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National University of Ireland, Cork



Antecedents of MHealth Inequalities  
And  
MHealth Equitable Service Model

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Thesis submitted for the degree of:

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I, Rowland Uche Njoku, certify that this thesis is my own work and I have not obtained a degree in the National University of Ireland, or any other University based on the work submitted in this thesis.

Rowland Uche Njoku

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## DEDICATION

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*“I can do all things through Christ who gives me strength”; to GOD be the glory.*

\*\*\*

*This dissertation is dedicated with love and affection to:*

*My Beloved Wife, Dr Chioma Ekelechi Njoku, and to*

*Our beloved children: Tobechukwu, Nora, David, Michael, and Victoria.*

*Thank you and God bless you for your love, companionship, and unwavering support.*

\*\*\*

*I also share my joy with my siblings and their families*

*Lady Chinyere, K.O. Njoku (Honourable), Lasbery, Sir Basil Ugo, Ethel, Hosanna and Peace*

*I thank you all for your love and encouragement, especially throughout the PhD program.*

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*I always cherish the loving memory of my beloved parents who gave us everything*

*Mr Samuel I. Njoku and Mrs Beatrice Njoku*

*Thanks for showing us “the faithful way” of our Lord Jesus Christ*

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*The Good Lord reward you for your love and support*

## ABSTRACT

The introduction of consumer MHealth technology is highly extolled for its potential to facilitate access to health, alleviate the shortage of health care resources, reduce hospitalization of patients, and mitigate health cost. The overwhelming endorsement shows the use of MHealth to complement existing healthcare infrastructure by targeting heterogeneous audience for specific health need. However, consumer MHealth innovation is traditionally considered for measures of coverage, efficacy, and cost-effectiveness with little discussion of the unintended consequences of escalating inequalities for underserved consumers of low socioeconomic populations. Furthermore, MHealth studies show that inequalities are fundamentally addressed as derivative of socioeconomic phenomenon without further explanation of how social and technology factors reinforce and aggravate its patterns. Therefore, the proliferation of consumer MHealth innovation and its concomitant health inequalities have important consequences. Researchers, managers, and other health information systems' stakeholders increasingly face the dilemma of reconciling the perplexing, and often contradictory rise in health inequalities in their commitment to implement MHealth innovation.

Existing studies reveal the paucity of empirical research and methodological limitation, including the lack of relevant theories to describe, explain or predict how sociotechnical mechanisms reinforce and aggravate inequalities in MHealth. Thus, the study of inequalities in consumer MHealth presents fundamental challenges relating to its substantive nature, its origin, and scope; as well as the methodological concern of how to address the anomalies.

It is therefore the objective of this research to address these gaps by exploring the antecedents of inequalities in consumer MHealth, and to resolve the following challenges: (1) the lack of consensus on the theoretical concepts of the relevant factors, (2) the elaboration of the relationship between the antecedent factors, and (3) to develop IS framework which can be used to mitigate inequalities in consumer MHealth innovation for PAB.

To achieve the above objective, the researcher adopted the interpretivist paradigm and qualitative approach as a reflective method to capture the emergent complexity of human sense making in a natural sociotechnical interaction between information technology, the people, and the context. Multiple case study and purposive sampling were also adopted to enable comparative selection of cases, and to intensify comprehensive data gathering that captures the richness of the cases. Accordingly, the prerequisite technology artefact was operationalised with MHealth for physical activity and fitness (PAF). Essentially, the aim was to document in

detail the conduct of everyday events in the implementation and use of MHealth for PAF and to identify the meaning assigned to these experiences by participants.

The research study was conducted in the Republic of Ireland (ROI); and the data collection occurred in the period between July 2019 and March 2020. Twenty-four individuals from twelve households of ethnic minority people of African background (PAB) participated individually in the data collection which involved demographic survey, observational data with think-aloud protocol (TAP), and role-play demonstration (RPD), as well as in-depth interviews. The lack of pre-existing notion of the MHealth phenomenon and the originality of this study necessitated the use of TAP and RPD, which were devised as templates to apprehend the true nature of the emerging phenomenon. The TAP and RPD are direct observational tools designed to illuminate human interactions which are situated in practice, to grasp knowledge that are mainly observed but absent from other documentation. The researcher reasoned that unless research participants are extremely insightful, they might not know or remember all the rationale for their behaviour. Thus, the researcher prepared and collected quantitative and qualitative data from each participant for eight weeks. Thereafter, the researcher organised all data with NVivo QDAS and concurrently conducted grounded theoretical analysis. The qualitative analysis resulted to categories and core categories which have explanatory and predictive powers and provide understanding of the inequalities in consumer MHealth.

Thus, this research study has immense contribution to IS theory and practice, especially for its novel methodology which uncovers the nine antecedents for examining inequalities in MHealth. Similarly, the discovery of the formative factors of inequalities in MHealth provides useful taxonomy, and clearly reveals that socioeconomic factor is one part of the nine antecedents that impact MHealth. Furthermore, the researcher developed the MHES model, and a framework to mitigate inequalities in consumer MHealth innovation. Consequently, the IS stakeholders, the PAB and underserved populations can leverage the MHESF at individual, social or organisational level to mitigate inequalities in consumer MHealth innovation.

However, the transdisciplinary nature of sociotechnical research such as this requires complementary representation from relevant IS reference disciplines, as well as greater involvement of MHealth stakeholders for richer insight. Furthermore, qualitative studies of this type are subjective, idiographic, and emic, with emphasis on relevance. Notwithstanding, this study paves way for mixed method research that combines relevance and theory verification.

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---

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---



## GLOSSARY

This Glossary provides a brief expansion of the abbreviations and acronyms that appear in this dissertation. In most cases such abbreviations are fully explained in the main text where they are introduced.

<b>Abbreviations</b>	<b>Expansion</b>
<b>BMI</b>	Body Mass Index
<b>DAS</b>	Data Analysis Software
<b>DHT</b>	Digital Health Technology
<b>MHealth Ecosystem</b>	A Complex Network of Interconnected System of MHealth
<b>EP Theory</b>	Theory For Explaining And Predicting
<b>EU</b>	European Union
<b>GPS</b>	Global Positioning System
<b>HER</b>	Electronic Health Record
<b>HIT</b>	Health Information Technology
<b>HIV</b>	Human Immunodeficiency Virus
<b>HSE</b>	Health Service Executive
<b>ICT</b>	Information And Communication Technology
<b>IS</b>	Information Systems
<b>IT</b>	Information Technology
<b>ITU</b>	International Telecommunication Union
<b>MHESF</b>	MHealth Equitable Service Framework
<b>MHESM</b>	MHealth Equitable Service Model
<b>MVPA</b>	Moderate To Vigorous Physical Activity
<b>PA</b>	Physical Activities
<b>PAB</b>	People Of African Background
<b>PAF</b>	Physical Activities And Fitness
<b>PEF</b>	Physical Exercise And Fitness
<b>NVIVO QDAS</b>	NVivo Qualitative Data Analysis Software
<b>QDA</b>	Qualitative Data Analysis
<b>ROI</b>	Republic Of Ireland
<b>RPD</b>	Role-Play Demonstration
<b>SE</b>	Socioeconomic
<b>SES</b>	Socioeconomic Status
<b>SWOT</b>	Strengths, Weaknesses, Opportunities, And Threats
<b>TAP</b>	Think-Aloud Protocol
<b>UTAUT</b>	unified theory of acceptance and use of technology



# CHAPTER 1.

## INTRODUCTION

### 1.1. Introduction to the Study

Chapter 1 introduces the research investigation in this thesis. The introduction provides the rationale for the study (section 1.2), identifies the research objective, the research questions, and the methodology applied (section 1.3). Furthermore, chapter 1 outlines the important contributions of this research (section 1.4) and presents the structure of this thesis (section 1.5) in relation to all the chapters.

### 1.2. Rationale for the Study

The introduction of MHealth is highly extolled for its potential to facilitate access to health (Graham & Kelly, 2004; Sanner, Roland, & Braa, 2012), alleviate the shortage of health care resources (Chib, van Velthoven, & Car, 2015), improve quality of health service (Shahriar Akter, D'Ambra, & Ray, 2010; Shahriar Akter & Ray, 2010b), and mitigate health cost (Cole-Lewis & Kershaw, 2010; Fiordelli, Diviani, & Schulz, 2013). However, MHealth is traditionally considered for measures of coverage, efficacy, and cost-effectiveness with little discussion of their unintended consequences of escalating inequalities within populations. Therefore the proliferation of consumer MHealth innovation and the concomitant health inequalities have important consequence (Evans, Whitehead, Bhuiya, Diderichsen, & Wirth, 2001; Sinha & Schryer-Roy, 2018). Researchers, managers, and health information systems stakeholders increasingly face the dilemma of reconciling the perplexing, and often contradictory rise in health inequalities in their commitment to implement consumer MHealth innovations (Hampshire et al., 2015; Jarke, 2018). Thus, the study of inequalities in consumer MHealth presents fundamental challenges which require further investigation.

The researcher conducted a literature review of inequalities in MHealth, which provided a comprehensive and up to date information of the body of knowledge. The aim of the literature review was to identify the research gaps and to categorise the research problems based on existing taxonomy and themes from the MHealth literature, as well as the characterisation created inductively from the reviewed literature.

The extant body of knowledge reveals a growing number of literature and MHealth potential to mitigate the limitations of healthcare service delivery (Armaou, Araviaki, & Musikanski, 2020; Bommakanti et al., 2020; Heitkemper, Mamykina, Travers, & Smaldone, 2017; Jennings & Gagliardi, 2013; Nelson et al., 2016). The literature also shows that although mobile information and communication technology (ICT) has revolutionised various commercial sectors, MHealth is in the introductory stage of transforming the limitations of traditional healthcare delivery (Steinhubl, Muse, & Topol, 2013). The MHealth body of knowledge focuses on the technology potential with outcome measures of individual units of analysis, and limited topic areas addressing the outcome at social level (Strauss & Corbin, 1990). The studies reveal methodological and theoretical limitation (Gregor, 2006; Hevner, March, Park, & Ram, 2004). Most of the studies are intervention experiments of MHealth implementation projects, which focus on the stakeholders' interest on the evolving potential of MHealth to facilitate timely and ubiquitous access to healthcare (Latulippe, Hamel, & Giroux, 2017; Sanner et al., 2012). The MHealth interventions are designed to alleviate the shortage of human and material resources in healthcare delivery (Mayberry et al., 2019) and mitigate health cost (Latulippe et al., 2017).

However, the literature also reveals that MHealth technology is traditionally considered for measures of coverage, efficacy, and cost-effectiveness with little discussion of the unintended escalation of inequalities in MHealth innovation (Evans et al., 2001; Sinha & Schryer-Roy, 2018). Similarly, MHealth studies show that inequalities are fundamentally addressed as derivative of socioeconomic phenomenon without further explanation of how technology and social mechanisms reinforce and aggravate its patterns (Arcaya, Arcaya, & Subramanian, 2015; Braveman & Tarimo, 2002; Graham & Kelly, 2004; Murray, Gakidou, & Frenk, 1999).

Thus, the study of inequalities in consumer MHealth present fundamental challenges relating to its substantive nature, its origin, and scope; as well as methodological concerns of how to address the anomalies (DiMaggio & Hargittai, 2001). In particular, inequalities and its interference in consumer MHealth innovation present fundamental theoretical problems relating to: the lack of consensus on important concepts; the absence of elaboration of the relationships among the constructs; and the absence of corroboration of relevant constructs and theory. (Kaiser & Presmeg, 2019, p. 83).

The foregoing gaps challenge our understanding of inequalities in consumer MHealth and corroborate the anomalous outcome of MHealth innovation for populations of interest. (Armaou et al., 2020; Baum, Newman, & Biedrzycki, 2012). As a result, a theoretically

grounded empirical research is required in order to develop more insights into the concept and the relationships among the constructs and relevant factors to address inequalities in MHealth innovation (Hsieh, Rai, & Keil, 2008). Shown in Figure 1.1 is a visual depiction of the gaps in the literature of inequalities in consumer MHealth.

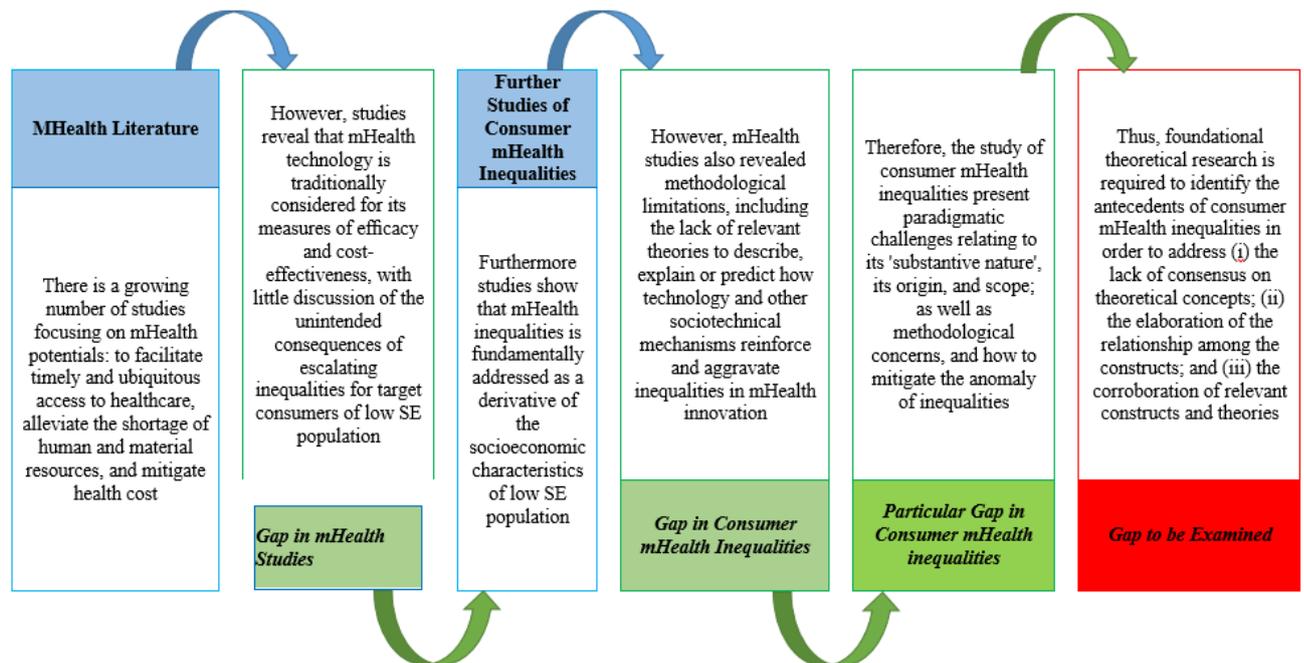


Figure 1.1 Visual Depiction of the Gap in Literature

The limitations outlined in section 1.1 and depicted in Figure 1.1 illustrates the gaps in the MHealth literature. The extant literature also reveals fundamental limitation with respect to the antecedents, and other formative factors which have to be unveiled to understand inequalities in consumer MHealth.

### 1.3. Research Objective, Research Questions and Methodology

To address the gap in the MHealth literature, this section highlights the research objective and research questions, as well as the research design of the thesis.

#### 1.3.1 Research objective, and questions to operationalise the objective

To address the gap in the MHealth literature, the objective of this research is: to explore the antecedents of inequalities in consumer MHealth innovation for the people of African

background (PAB) in the Republic of Ireland (ROI), and to develop IS framework to mitigate inequalities in consumer MHealth innovation.

To operationalise the research objective, three research questions are germane:

- **Research question 1:** What are the antecedents of inequalities in consumer MHealth innovation for the people of African background (PAB) in the Republic of Ireland (ROI)?
- **Research question 2:** What are the relationships between the antecedent factors and inequalities in consumer MHealth innovation for people of African background (PAB)?
- **Research question 3:** What IS framework can we develop to mitigate inequalities in consumer MHealth innovation for people of African background (PAB)?

The above research questions are exploratory in nature (Fitzgerald & Howcroft, 1998; Ponelis, 2015). This research has taken an exploratory approach to address the scarcity of literature in MHealth inequalities at individual units of analysis, and to provide a rich understanding of the phenomenon for the population of interest (Jaeger & Halliday, 1998; Ponelis, 2015). By its nature exploratory research surrounds technology innovations and focuses on contemporary phenomenon such as consumer MHealth innovation (Jaeger & Halliday, 1998). It is impossible to manipulate inequalities in MHealth and its subjects; therefore it has to be studied in its natural setting, which also provides an opportunity to conceive a hypothesis that can improve the undeveloped and limited knowledge of this phenomenon (Ponelis, 2015).

### **1.3.2 Research methodology: Interpretivist paradigm**

To address the research questions and achieve the research objective, the researcher adopted the interpretivist paradigm. The interpretivist paradigm is the assumption that knowledge is socially constructed in the mind of the individuals (Bodner, 1986; Guba & Lincoln, 1994). A reasoned and reflective adoption of the interpretivist paradigm, and a qualitative approach suggest a position which captures the social technical interaction between information technology, the people and the organisational contexts (Orlikowski & Baroudi, 1991; Orlikowski & Robey, 1991).

Essentially, the aim is to document in detail the conduct, interpretation, descriptions, sounds, words and expressions of everyday events in the implementation and use of consumer MHealth and to identify the meaning which have been assigned to these experiences by participants and

the researcher who witness them (Erickson, 2012). The interpretivist paradigm is best suited to capture the complexity of human sense making in natural setting by using data in the form of words rather than numbers to capture the situation as it emerges (Ritchie, Lewis, Nicholls, & Ormston, 2013).

To address research question 1, this study aims to capture the differences in the consumer MHealth experience, and the meaning assigned to those experiences by the witnesses. The target is to gather rich contents of the event-narratives (qualitative) of social interactions and the meanings assigned to them (perspectives), rather than quantitative measurement (Erickson, 2012; Ritchie et al., 2013). The overriding focus is on the significance of the events that shape the perception of MHealth events which represent the exclusion of the participants. Adopting the interpretivist stance means that our knowledge of reality is gained only through social constructions which derive from rich and quality data such as words of the language, pictures, descriptions and narratives direct from the research participants to the researcher (Ritchie et al., 2013). Rich narrative of the phenomenon enables the researcher to further advance a model to represent the relationship among the constructs.

### **1.3.3 Multiple case study**

Multiple case study was considered suitable to enable a comprehensive data gathering that captures the richness of the case and the context (O'leary, 2004). Multiple case study is also suitable to support a comparison for comprehensive understanding of the phenomenon (O'leary, 2004; Wahyuni, 2012). Especially, cases are selected because they are suitable for illuminating and extending relationship and logic among constructs (Eisenhardt & Graebner, 2007). Theory from multiple cases are better grounded in varied empirical evidence, which are more accurate and more generalizable (Eisenhardt & Graebner, 2007). The researcher's choice of methodology in this research is qualitative, exploratory, inductive and idiographic (Eisenhardt, 1989; Fitzgerald & Howcroft, 1998). Details of the paradigmatic assumption for this research is covered in detail under research methodology in Chapter three.

## **1.4. Important Contributions of this Research**

This thesis outlines key theoretical and practical contributions in the following sections.

### **1.4.1. Key theoretical contributions**

The study of inequalities in consumer MHealth, in its current state, present paradigmatic challenges relating to its substantive nature, its origin, and scope; as well as methodological concerns of how to address the anomalies (DiMaggio & Hargittai, 2001; Weiss & Eikemo, 2017). In particular, inequalities and its interference in consumer MHealth innovation present foundational theoretical problems relating to: the lack of consensus on important concepts; the absence of elaboration of the relationship among the constructs; and the absence of corroboration of relevant constructs and applicable theories. (Kaiser & Presmeg, 2019, p. 83).

#### 1.4.1.1. Contributions to MHealth research

##### a. Antecedents of inequalities in consumer MHealth

This study provides a useful taxonomy and uses a novel methodology to uncover the nine antecedents for explaining inequalities in consumer MHealth. Previous studies argue that inequalities in consumer MHealth innovation is a derivative of low socioeconomic status. However, in chapter four, the study shows that demographic and low socioeconomic status represent one aspect of the nine antecedents of inequalities in consumer MHealth innovation. This study also shows that demographic and socioeconomic factors impact the inequalities in MHealth utilisation. Inequalities in MHealth utilisation is the intermediate factor which directly impacts the inequalities in consumer MHealth. The antecedents and how they link to the intermediate factors in consumer MHealth are discussed in detail in chapter five.

##### b. Relationship between the antecedents and the inequalities in consumer MHealth

The traditional focus of MHealth studies reveal the crucial need for a paradigm shift. Especially, the extant literature currently addresses digital inequalities as socioeconomic derivative without further explanation of how technology mechanisms reinforce and aggravate the patterns of inequalities in the application of digital health innovations. This fundamental gap requires theoretically grounded empirical research to expand our understanding of the substantive nature of inequalities in sociotechnical environment of MHealth innovation (Hsieh et al., 2008).

In chapters five, the path diagrams provide the description of the relationship between the antecedent factors, and further illustrates how technology mechanisms reinforce and aggravate patterns of inequalities in consumer MHealth. Chapter five addressed research question 2 and helps to conceptualise the relationship among the antecedents of inequalities in consumer

MHealth. The relationship among the antecedents provides a model for explaining and predicting (EP) the underlying factors of the MHealth phenomenon (Gregor, 2006). The knowledge of inequalities in MHealth is improved through the development of “EP theory” for “explanation and prediction”, as well as description of the relationship among the factors (Gregor, 2006; March & Smith, 1995).

### c. MHealth equitable service framework

The research develops the MHES framework which recognises that inequalities are the outcome of stakeholders’ activities and interests across the sociotechnical environment of the MHealth ecosystem. Previous studies conceived inequalities in MHealth as a derivative of low socioeconomic phenomenon. Overwhelming endorsement shows how health service providers use the MHealth interventions to exclusively target the risk behaviour of patients. Thus, MHealth was used as the instrument for targeting low socioeconomic patients, who are consequently treated as both perpetrators, as well as the victims of inequalities of consumer MHealth. Some authors argue that the use of MHealth for “behavioural adherence” is tantamount to “victim blaming ideology” for low SE populations (McLeroy, Bibeau, Steckler, & Glanz, 1988).

This study develops the MHES framework which recognises that inequalities are not just the result of low socioeconomic status or consumers’ risk behaviour, but rather, the outcome of activities and interests of the MHealth stakeholders across the entire sociotechnical environment of the MHealth ecosystem.

#### 1.4.1.2. Contributions to information systems’ research

##### a. Methodology provided opportunity to hear from a voiceless population

The methodology is a novel illustration of how theory building approach can provide insight into an under-investigated subject, by using multiple sources of qualitative data from TAP, RPD and in-depth interview to facilitate theory building. This research design involves the use of TAP, and the RPD, as well as in-depth interview, which made it possible for the participants to be deeply immersed into the socio-technology experience. The methodology also provides opportunity to voiceless population and the hard-to-reach, by offering them the voice to speak-out. In addition, the study covers the breath of the four phases of technology experience during MHealth formative stage of pre-implementation, and the implementation process, as well as the usage phase. This rigorous approach is a novel research methodology that represents a

scientific contribution which was not previously documented in any known qualitative IS research.

#### b. [Erroneous extrapolation of traditional measures of inequalities in MHealth](#)

Most importantly this study has paramount implication for social research, especially the IS discipline, which erroneously extrapolates the traditional measures of inequalities in a disproportionate way which undermines the underserved minorities, or the hard-to-reach as they are pejoratively called.

### **1.4.2. Key practical contributions**

#### 1.4.2.1. Path diagram provides explanation for understanding inequalities in MHealth

The antecedents and the intermediate factors provide a clear path for the explanation, and prediction, as well as the understanding and application of inequalities in consumer MHealth innovation. This study helps MHealth stakeholders understand the antecedents of MHealth inequalities in a naturalistic context, through the in-depth accounts of the unique experiences of minorities. In other words, it exposes and empirically addresses the new ways by which digital technologies such as MHealth innovations generates unfair differences and disadvantages that give rise to inequalities and presents how to mitigate it.

#### 1.4.2.2. The MHealth equitable service framework to mitigate inequalities

Chapter six focuses on research question 3; it develops IS framework to mitigate inequalities in consumer MHealth innovation for PAB, which is useful for research and practice. MHES framework is designed to provide equitable remedies in the activities and interest of the MHealth stakeholders within the overall MHealth ecosystem.

#### 1.4.2.3. Advocacy for social justice and equity in technology innovation

Inequalities dehumanise and impact the life of minority populations in multiple ways; it aggravates ill-health, limits life expectancy, and reduces human productivity, as well as increases the social and economic cost of living. In all its forms, inequalities perpetuate adverse experiences in its differential outcomes which are unfair, unjust, unnecessary and avoidable (LaVeist, Gaskin, & Richard, 2011; Rehm et al., 2009). For the underprivileged or low SE populations, inequalities represent a formidable challenge in several trajectories of life, arising from disproportionate use of power, authority, or influence, as well as unequal application and use of technology innovations. Consequently, the development of the MHES framework compels researchers, practitioners, and other MHealth stakeholders to seize the opportunity to

integrate social justice and equity as part of their collective and communal responsibility in the delivery of digital innovation. Inequalities represent a vicious cycle that impels us to combine equity, fairness, and justice in the ongoing digital health transformation, in which MHealth innovation is playing the dual role of both the instrument and the measure of success.

#### 1.4.2.4. Mitigate the rise in inequalities in the implementation of MHealth innovations

Although consumer MHealth innovation is an integral part of a broader interpretation to address disparities in health; it is a paradox that its application concomitantly evolves new patterns of inequalities that adversely exacerbate the health gap among low SE populations. Researchers, practitioners, and other health information systems' stakeholders face the dilemma of reconciling the perplexing, and often contradictory rise in health inequalities in their commitment to implement consumer MHealth innovations.

#### 1.4.2.5. Practical contribution to PAB population

This research has practical contribution to PAB population through the opportunity created by the research methodology to capture the hidden experiences of the underserved and voiceless population. Furthermore, the MHES framework has implications for the PAB population, who now have the opportunity to leverage the dynamics of group interaction, within family members, and among friends, as well as peer groups, as important sources of influence to address equity in MHealth. The MHES framework also creates opportunity for PAB to benefit from organised involvement of professionals and health organizational stakeholders who have the competence to organise and address issues at higher levels. Especially, professional, and organisational stakeholders have the opportunity and competence to regulate the quality of equipment to improve access, recommend guidelines, provide social and material support, and supervise positive national policy for equity in MHealth.

## 1.5. Thesis Structure

This thesis is composed of seven chapters which are outlined as follows:

### 1.5.1 Chapter two reviews the MHealth literature

Chapter two presents the review of the MHealth literature starting with a definition of the HIT and its subset, the eHealth. The chapter highlights the ubiquitous characteristics of Mobile IT as the drivers of MHealth. Although MHealth is extolled for its potential to complement existing healthcare infrastructure, there is little discussion of the unintended consequence of

the escalating inequalities. The literature also reveals that inequalities in MHealth are fundamentally addressed as derivative of SE phenomenon without further explanation of how technology and social mechanisms reinforce and aggravate its patterns. MHealth is traditionally used to focus on low SE population as the target consumers. The literature review further highlights the common vulnerabilities shared by low SE populations and the PAB. MHealth studies reveal the paucity of empirical research and methodological limitation, including the lack of relevant theories to describe, explain or predict how sociotechnical mechanisms reinforce and aggravate inequalities in consumer MHealth innovation.

### **1.5.2 Chapter three presents the research philosophy and the methodology**

Chapter three presents the research philosophy and choice of methodology for this research. Chapter three began by restating the research objective and research questions and outlined basic assumptions of alternative paradigms of inquiry. The researcher opted for a constructivist paradigm required for understanding contemporary events in the context in which the phenomenon occurs. The researcher selected a qualitative research design with multiple case study suitable for delving deeper, and for deriving a rich and detailed data required to build theory based on holistic understanding in a naturalistic inquiry.

The qualitative data were organised with NVivo QDAS, and concurrently analysed using grounded theory methodology. The qualitative data analysis process resulted to development of categories and core categories which have explanatory and predictive powers and provide understanding of the inequalities in consumer MHealth.

### **1.5.3 Chapter four presents the study findings for the antecedents of inequalities**

This chapter addresses the fundamental theoretical problem of the lack of important concepts by uncovering the antecedents of inequalities in consumer MHealth innovation. Drawing from chapter three, section 4.2 addresses research question 1 and presents the antecedents of inequalities in consumer MHealth innovation for PAB. Section 4.3 presents all the antecedent factors and illustrates how each of the nine antecedents impact the intermediate factors of inequalities in consumer MHealth. In this section all the antecedents of inequalities in consumer MHealth are further defined with their corresponding citation evidence.

Section 4.4 shows the intermediate factors of inequalities in consumer MHealth and provide the illustration of their relationship with the antecedents. The connection between the

antecedents and the intermediate factors is the subject of research question 2, to be addressed in chapter six. Section 4.5 presents the chapter summary and conclusion

#### **1.5.4 Chapter five presents how antecedents link to MHealth inequalities**

Chapter five focused on research question and illustrates the relationship between the antecedents of inequalities in consumer MHealth innovation. Section 5.2 presents the answer to research question 2 by focusing on the development of the relationship between the antecedents and inequalities in consumer MHealth. Section 5.3 elaborates on the relationships between the antecedents and the intermediate factors of inequalities in consumer MHealth. Section 5.4 illustrates the links between antecedents, intermediate constructs and MHealth Inequalities. It further shows that inequalities in consumer MHealth is a formative factor of third-order hierarchical model. It shows the missing factors and presents the MHESM.

#### **1.5.5 Chapter six develops an IS framework**

Chapter six focuses on research question 3 by developing IS framework to mitigate inequalities in consumer MHealth innovation. Section 6.2 introduces the process of mitigating inequalities in consumer MHealth innovation. Section 6.3 presents the MHealth equity service (MHES) framework which can be applied to mitigate inequalities in consumer MHealth innovation. Section 6.4 conceptualises MHESF matrix as a system change framework encompassing the sociotechnical environment across all levels of the MHealth ecosystem.

Section 6.5 illustrates the composition of the MHESM factors with matrix table of nine equity factors and five MHealth ecosystem factors. It further illustrates how equity factors may be placed on the horizontal axis with corresponding five ecosystem factors on the vertical axis, or alternatively. This section illustrates how equity factors are consequently integrated into the cross points of the MHESF matrix table which is designed to counteract inequalities in MHealth. The MHES framework addresses inequalities as the outcome of activities and interests of the MHealth stakeholders across the entire MHealth sociotechnical environment of the MHealth ecosystem. This elaboration reveals that the ecosystem approach is distinguished from the extant position which focuses on low socioeconomic characteristics and the risk behaviour of the MHealth consumers. Section 6.6 presents the chapter summary and conclusion.

### **1.5.6 Chapter seven presents a concise discussion of the research findings**

Chapter seven draws from previous chapters to discuss the research findings. It highlights the contributions of this study to current theory and practice. It summarises the findings presented in previous chapters. It presents the findings in chapter 4 for research questions 1 and unveils the antecedents of inequalities in consumer MHealth innovation for the population of interest. It presents chapter 5 with respect to research question 2, and the relationship between the antecedents and inequalities in consumer MHealth innovation. It also summarises chapter six in response to the research question 3, by developing IS framework to mitigate the inequalities in consumer MHealth innovation.

Chapter seven begins in Section 7.2 with a summary of the research objective and the methodology used to achieve this objective. Section 7.3 concisely teased out the study findings for research question 1, research question 2, and research question 3. Section 7.4 presents the research study contributions to theory and to practice. Section 7.5 highlights the implications of the research findings. Section 7.6 presents the potential limitations, and the future research opportunities. The chapter ends in Section 7.7 with the concluding remarks.

## **CHAPTER 2.**

### **LITERATURE REVIEW**

#### **2.1. Introduction**

Chapter 2 presents a critical overview of the existing knowledge of inequalities in consumer MHealth innovation. The literature review describes health information technology (section 2.2) and distinguishes eHealth as a type of HIT which relies on IT for its role in health delivery process. Section 2.3 presents the characteristics of Mobile IT that makes it useful for healthcare delivery. Section 2.4 highlights the important characteristics of MHealth and provides a working definition to be followed in this research.

The review in section 2.5 presents various users of MHealth and highlights the important roles of MHealth in healthcare delivery process. Section 2.6 discusses the escalation of inequalities focusing on the underserved people of African background (PAB). Furthermore, the chapter presents the current state of MHealth research, and the limitations. Section 2.7 provides the summary and conclusion of the literature review.

#### **2.2. Health Information Technology (HIT) and E-Health**

Information technology (IT) describes the combination of computer technology (hardware and software) with telecommunication multimedia (data, image, video, and voice) networks (Benbasat & Zmud, 2003; Brynjolfsson & Yang, 1996). As applicable in other industries, IT has also become a viable support for improving service in healthcare delivery, in the form of Health Information Technology (HIT), also known as “digital health technology” or eHealth (Becker et al., 2014; WHO, 2011). Therefore, digital health technology or eHealth (integration of IT with health care), is a type of HIT designed to provide information needed to support healthcare services. As the integration of IT into healthcare continues to evolve, the identity of digital health technology continues to unfold. Thus, digital health literature remains in a flux, and continues to evolve in its definition of terms.

The world health organisation defined MHealth as a subset of eHealth (WHO, 2011). The acronym attached to e-health is a short form of electronics and communication technology or ICT networks which represents the integration of internet technology with healthcare (Pagliari

et al., 2005). Therefore, the term eHealth is similar to the use of other acronyms such as e-commerce, to imply online, internet or electronic commerce (Pagliari et al., 2005).

However, it is important to distinguish eHealth (computer hardware and software, combined with IT networks) from other independent health technologies. Independent health technology is used here to refer to “health equipment” which operate offline as silo systems, with no capability of direct integration with Public IT Networks or the Internet (WHO, 2011a). Such health technologies or independent medical technology devices include, for example, blood pressure monitoring devices, or blood glucose monitoring devices, which normally do not need to operate by direct connection with IT networks (Alsos, Das, & Svanæs, 2012; Cousins & Robey, 2005; WHO, 2011a). These medical devices and health technologies are variously categorized and certified according to international and national labelling requirements for medical products (Network, 2010; Sidebottom, 2003). Thus, eHealth is an umbrella terminology for the integration of “IT and healthcare technology”. Therefore, e-Health can be named in two categories: the stationary HIT, and the mobile HIT (Alsos et al., 2012; Pagliari et al., 2005). Both stationary and mobile HITs constitute what is called digital health technology (DHT) or eHealth. Thus, some definitions broadly identify “digital health technology” or eHealth as “the field of knowledge and practice associated with the development and use of digital technologies” (Crawford & Serhal, 2020; Dhingra & Dabas, 2020). The field of e-Health has continues to evolve, which includes telehealth, mobile health apps, wearable technologies, and online health services and technology tools that are designed to support healthcare (Crawford & Serhal, 2020; Dhingra & Dabas, 2020).

## **2.3. Mobile IT: Definition and Characteristics**

### **2.3.1. Mobile IT Definitions**

Mobile IT is defined as “mobile communication device” that makes it possible for people to communicate independent of location . Mobile IT (or mobile ICT) is also described as an adaptive communication and computing service (Kleinrock, 2001). Mobile IT definitions highlight its important attribute as a facilitator of communication, which is independent of location (Kleinrock, 2001). Some other definitions focus on its “advantage of ubiquitous wireless communication” (Jarke, 2018; Varshney, 2003). These definitions characterise and highlight the composite attributes and the technologies involved in mobile IT, such as software, hardware, and the communication networks (Ahluwalia, Varshney, Koong, & Wei, 2014).

Other characteristics of the mobile IT are the features such as the wireless connectivity, portability, accessibility, as well as the user interface (Jarvenpaa, Lang, & Tuunainen, 2005). In terms of functionalities, mobile IT collects, processes, stores, and communicates information (Basole, 2004). Mobile IT is an evolving technology which continues to incorporate new functionalities and features (WHO, 2011).

### **2.3.2. Mobile IT hardware and software**

The mobile IT definitions highlight its combination of various technologies of hardware computing, software applications and communication networks (Ahluwalia et al., 2014). The mobility factors of mobile IT devices combine the physical form factors with the wireless, portable and handheld features of the hardware (Alsos et al., 2012), as well as the ubiquitous service of the mobile telecommunication networks (Coulson, Blair, Clarke, & Parlavantzas, 2002; Cousins & Robey, 2005). Examples of mobile devices range from Smartphones, Tablet Pc's, Personal Digital Assistants PDAs, Smartwatches, and Wearable Devices. (Coulson et al., 2002; Cousins & Robey, 2005; Huang, Wong, & Pietka, 1997). Mobile IT devices operate on mobile power such as batteries which have relatively smaller sizes and may either be replaceable or rechargeable (Hui & Ho, 2005; Liang et al., 2019). Similarly, the mobile IT software characteristics derive from the mobile IT software application programs, which are designed to enhance mobility, and assist the user to carry out specific tasks (Jarvenpaa & Lang, 2005; Scheepers & Scheepers, 2004).

### **2.3.3. Mobile IT functions and communication networks/Internet**

The mobile IT functions capture and manage data to produce useful information required to support various levels of users. The Mobile IT functions describe the services the technology delivers to users. The mobile IT functions can be decomposed into other sub functions and eventually into processes that do specific tasks (Junseok Kim, Kim, & Choi, 2017). The mobile IT functions can be described in terms of the information tasks such as data collection, storage, processing, and communication. For example, mobile data collection involves the capture of mobile data inputs through the user interface, keyboard, camera, sensors, GPS and other input resources (Alsos et al., 2012). Similarly, mobile IT data processing is an internal system function within the device processors for the manipulation of data (Huang et al., 1997). The mobile IT data storage is handled by the system memories and registers (Lyytinen et al., 2004; Wiredu & Sørensen, 2006). The mobile IT data communication manages the transmission and

reception of multi-media data in the form of text, image, audio, video, and animation (Ahluwalia et al., 2014; Huang et al., 1997; Varshney, 2003).

Furthermore, the rising need for data protection and security is a cross cutting function which derive from emerging emphasis to protect digital information from unauthorized access, corruption, or theft at both the system level and user service level (Jarvenpaa & Lang, 2005; Jarvenpaa et al., 2005; Varshney, 2003).

## **2.4. MHealth Definitions and Characteristics**

### **2.4.1. MHealth definitions**

MHealth service is defined by Shahriar Akter et al. (2010) as “a personalized and interactive service whose main goal is to provide ubiquitous and universal access to medical advice and information to ... customers over any mobile device”. Literature shows that MHealth is emerging as a new kind of front-end access to public services with specific capabilities of delivering “on demand real time” information (Braa & Sanner, 2011; Germanakos, Mourlas, & Samaras, 2005).

Various literature definitions exist for MHealth focusing on its features and functions (Cameron, Ramaprasad, & Syn, 2015). Variations in MHealth definitions portray the varieties of the mobile applications and the continued technology proliferation and advancements (Armaou et al., 2020). Also, disciplinary influence has played important roles in shaping the nature of MHealth definitions. Various definitions have emerged from different disciplines to emphasise a particular view of MHealth (Shahriar Akter & Ray, 2010a; Kay, Santos, & Takane, 2011; Qiang, Yamamichi, Hausman, Altman, & Unit, 2011).

### **2.4.2. MHealth characteristics**

The MHealth literature focused on various themes and characterisation for the definition of MHealth. The characteristics include both the form factor and the communication functions described in the following sections.

#### **2.4.2.1. MHealth Form Factor**

The MHealth form factors include the user interface and the physical features which underline the important aspects of the MHealth technology (Alsos et al., 2012). The form factors and the interface include the usability of the display screen, the portable size, and mobility features which enable the MHealth to be used as a handheld device (Alsos et al., 2012). These form

factors are the focus of technology designers focusing on mobility and targeting users for adoption of the MHealth technology .

#### 2.4.2.2. MHealth Communication

The MHealth communication function provides multimedia mobile and wireless telecommunication which allows ubiquitous access to information through text, image, audio, or video interaction between remote locations (Shahriar Akter, D'Ambra, & Ray, 2011; Chatterjee, Chakraborty, Sarker, Sarker, & Lau, 2009). MHealth also allows personalised mobile telecommunication between two parties, including multiparty interactive communication (Shahriar Akter et al., 2010).

#### 2.1.1.4 MHealth Interface, form factor and communication combined

The uniqueness of the interface, form factor and multimedia wireless telecommunication are the major characteristics which uniquely identify the MHealth technology and its services (Shahriar Akter et al., 2011; Chib et al., 2015). The ubiquity of global wireless mobile communication is combined with the portability of the MHealth technology to bridge the access gap of public healthcare service at any location (Bardram, Baldus, & Favela, 2007; Yang & Varshney, 2016).

#### **2.4.3. Working definition for MHealth**

MHealth is the combination of mobile technology (mobile hardware and software) with telecommunication (data, image, video and voice) networks, that are designed to collect, process, store and communicate the information required to support healthcare at any location (Becker et al., 2014; Jarvenpaa & Lang, 2005; Whitten & Bentley, 2007). A broad definition of MHealth has played important role in the empirical field for understanding the nature and functions of MHealth. The World Health Organization (WHO) Global Observatory for eHealth (GOe) defines MHealth broadly as “any medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices” (Ryu, 2012; WHO, 2011, p. 6). The above definition is a general description of MHealth, however, the application of MHealth involves combinations of technology devices and ubiquitous communication . In practice, MHealth can be a single device or a collection of devices; therefore it is simply defined in this study as “the use of mobile technology (e.g., smartphones) and software (i.e., applications) to facilitate or enhance health care” at any location (Erbes et al., 2014).

#### 2.4.3.1. Consumers of MHealth

The consumers of MHealth refer to personal, direct, or self-users, such as individuals who are potential or current personal users of MHealth at home, and includes users for exercise and physical fitness (Pita-Barros, Bourek, Brouwer, & Lehtonen, 2019). Consumer MHealth are designed for the personal use of individuals of general population (Akbar, Coiera, & Magrabi, 2020; Or & Tao, 2014; Pham et al., 2019; Rai, Chen, Pye, & Baird, 2013).

#### **2.4.4. MHealth drivers**

##### 2.1.1.5 Global communication network-coverage and mobile phone subscriptions

The rising interest in MHealth studies derive from the continued growth in mobile communication network-coverage and the global rise in mobile phone subscriptions (Bastawrous, Hennig, & Livingstone, 2013; Kay et al., 2011). According to the International Telecommunication Union (ITU), there is an uptake of more than five billion wireless phone subscriptions which represent more than 85% of the world's population (Kay et al., 2011; Kyem & LeMaire, 2006). Studies also show that the widespread of ICT networks and global penetration lend themselves to innovations in several industries, including national and global health service deliveries (Kay et al., 2011).

The World Health Organization's (WHO) Global Observatory group survey, in 2010 and 2011, reported of high adoption of MHealth projects worldwide (Shahriar Akter & Ray, 2010b; Kay et al., 2011). Research studies and findings of the WHO reports show the rising use of MHealth in many platforms to support various aspects of health care program objectives, such as health care emergency, decision support systems, health promotion, disease surveillance, patient monitoring, patient records, treatment compliance, community mobilization, appointment reminders, et cetera. (Kay et al., 2011; Tomlinson, Rotheram-Borus, Swartz, & Tsai, 2013b).

##### 2.4.4.1. Potentials of MHealth applications

The state-of-the MHealth field reveals a growing number of studies focusing on MHealth potential to facilitate timely and ubiquitous access to healthcare, alleviate the shortage of human and material resources, and mitigate health cost. In particular, MHealth has potential to complement existing healthcare infrastructure by targeting heterogeneous audiences and addressing specific health needs of a population (Fiordelli et al., 2013).

#### 2.4.4.2. Unintended Inequalities in MHealth

Extant studies reveal that MHealth technology is traditionally considered for its measures of efficacy and cost-effectiveness, with little discussion of the unintended consequences of the systematic differences which are unjust, unfair, unnecessary, and avoidable for underserved consumers of low SE population. This unintended consequences in the application of MHealth is shrouded in debate which forms part of the discussion in this chapter (Baum et al., 2012; Latulippe et al., 2017).

## 2.5. MHealth Literature

### 2.5.1. Historical Background of the MHealth Literature

MHealth research literature dates back to the beginning of the “wireless telemedicine...” (Laxminarayan & Istepanian, 2000) in the early years of the 2000 millennium (Tamrat & Kachnowski, 2012). In the year 2000, the popularity and widespread adoption of mobile phones had begun and revolutionised the commerce industry (Kalba, 2008). The rising global penetration of the mobile phone networks and its widespread adoption in remote populations worldwide became an opportunity to leverage its potential to improve the perennial health care access and rising cost (Shahriar Akter & Ray, 2010b). From the 2000 millennium to the present time, there have been great shifts in the MHealth landscape and development goals (Norris, Stockdale, & Sharma, 2009).

In the IS literature, the current state of knowledge shows a large but still evolving MHealth in its research streams and practice (Lowe & Hartley, 2018). In addition to the phenomenal growth in the MHealth field (Steinhubl, Muse, & Topol, 2015), the literature also presents an evolving characteristics (Oldenburg, Taylor, O'Neil, Cocker, & Cameron, 2015). “MHealth” spelling remains anomalous, and is sometimes written with capital M (MHealth), or separated with a hyphen, as in M-Health or m-Health (Benbasat & Zmud, 2003).

Thus, the IS literature contain varying MHealth definitions from several authors (Kay et al., 2011; Qiang et al., 2011), which apparently reflect the novelty of the MHealth domain . The studies also show that growing number of researchers from various academic disciplines approach the MHealth research using different paradigms . The multidisciplinary attributes of MHealth have played significant role in its evolution, and research landscape (Kay et al., 2011; Schueller, Muñoz, & Mohr, 2013). Therefore, MHealth as an emerging field is defined by various authors from varying viewpoints which sometimes differ according to disciplines

(Shahriar Akter & Ray, 2010a; Kay et al., 2011; Qiang et al., 2011). Furthermore, the role of the MHealth depends on its interconnection with other wireless health technologies, such as eHealth, telehealth and telemedicine, which quite often interwork together in the healthcare delivery process (Kreps & Neuhauser, 2010).

## **2.5.2. Gathering the literature, and the search outcome of inequalities in MHealth**

### **2.5.2.1. MHealth Interface, form factor and communication combined**

The researcher conducted a literature review of inequalities in MHealth, which provided a comprehensive and up to date information of the body of knowledge. The aim of the literature review was to identify the research gaps and to categorise the research problems based on existing taxonomy and themes explicitly identified or implicitly derived from the reviewed literature.

Searches were conducted on relevant online databases, for articles published in English, between 2012 and 2020. The online database searches targeted the titles of articles with the search phrase formed from the word “MHealth” or “mobile health” in combination with in/equality, in/inequalities, in/equity, or in/equities.

The exact searches were conducted for titles with the word phrases formed from the MHealth combination, which include: “(MHealth AND inequality) OR (MHealth AND inequalities) OR (MHealth AND equality) OR (MHealth AND equalities) OR (MHealth AND inequity) OR (MHealth AND inequities) OR (MHealth AND equity) OR (MHealth AND equities)”. Similarly, more searches were conducted for titles with the word phrases formed from the mobile health combination, which include: “(mobile health AND inequality) OR (mobile health AND inequalities) OR (mobile health AND equality) OR (mobile health AND equalities) OR (mobile health AND inequity) OR (mobile health AND inequities) OR (mobile health AND equity) OR (mobile health AND equities)”.

### **2.5.2.2. The literature search outcome of the inequalities in MHealth**

The outcome of the literature search for inequalities in MHealth retrieved 22 articles in total from which 21 samples were finally selected. The selected articles were organised in a table of reviewed literature (see appendix 1) to enable conceptual analysis of the literature items.

Initial look at the information on the table of reviewed articles shows that the years 2016 to 2020 marked an increased number of article publications (Figure 2.1).

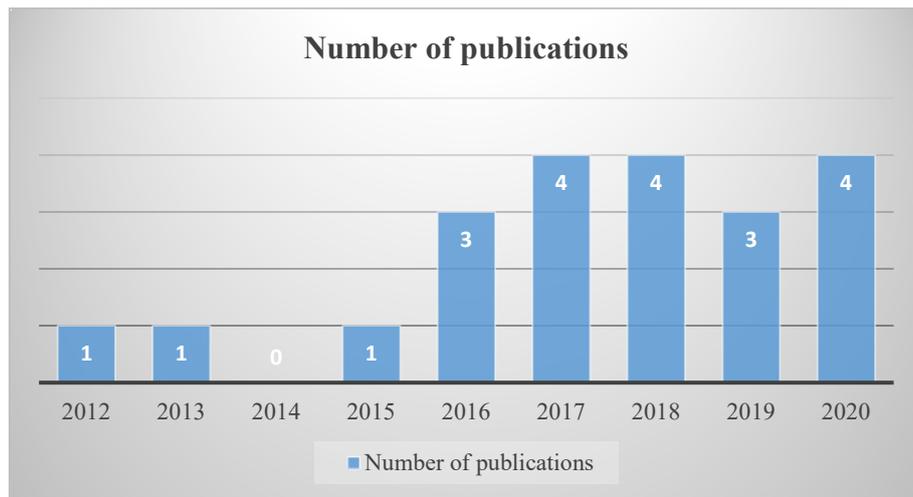


Figure 2.1 Publications per year of reviewed articles from the year 2012 to 2020

### 2.5.3. Evaluation of MHealth research literature (Appendix A)

The researcher conducted the analysis of the MHealth literature, which provided a comprehensive and up to date information of the MHealth body of knowledge. The aim of the literature analysis was to identify the research gaps and to categorise the research problems using characterisation created inductively from the reviewed literature, as well as from the existing taxonomy and themes of the extant MHealth body of knowledge. The MHealth research literature was organised under the relevant headings which include the following list of criteria: the research topics as outcome measures of MHealth, main areas of health service delivery where MHealth was used, as well as the user categories of MHealth. Further evaluation of the MHealth literature focused on target population of MHealth research, the research designs and theories used, as well as the focus on inequalities as the unintended consequence in MHealth research.

### 2.5.4. MHealth research focused on outcome measures of MHealth

The literature was first organised by focusing on the research topics as outcome measures of MHealth. MHealth have been organised by outcome measures in previous reviews (Shahriar Akter, D'Ambra, & Ray, 2013; Tomlinson, Rotheram-Borus, Swartz, & Tsai, 2013a).

The outcome measures of MHealth include themes such as MHealth design, development, and implementation (Diez-Canseco et al., 2015; Hallberg et al., 2014). MHealth readiness (Khatun, Heywood, Ray, Bhuiya, & Liaw, 2016). and MHealth adoption (Chib et al., 2015; Hoque, 2016; Leigh & Ashall-Payne, 2019). Research also addressed MHealth acceptability

(Beratarrechea et al., 2015; Feinberg et al., 2017; Lodhia, Karanja, Lees, & Bastawrous, 2016), usability and feasibility (Vedanthan et al., 2015).

Research themes also focused on the use of MHealth (Beratarrechea et al., 2016; Garner, Sudia, & Rachaprolu, 2018), and users behaviour in terms of adherence (Anglada-Martinez et al., 2015; Badawy et al., 2017; Bobrow et al., 2016; Leon, Surender, Bobrow, Muller, & Farmer, 2015). A measure that is dominant is the effectiveness of MHealth (Lee et al., 2016; Müller, Alley, Schoeppe, & Vandelanotte, 2016). Measure of engagement (Barello, Graffigna, Vegni, & Bosio, 2014), service quality (S. Akter, D'Ambra, & Ray, 2010; Doocy et al., 2017), and inequalities (Jarke, 2018; Latulippe et al., 2017; Mayberry et al., 2019; Régnier & Chauvel, 2018). These are mainly community interventions and controlled clinical trials which seem to reveal that MHealth is at the introduction phase its journey into the health care service. Table 2.1 shows how MHealth is organised by its measures.

Table 2.1 Organising MHealth studies by its measures

<b>MHEALTH LITERATURE TOPICS</b>	
<b>Design , development and implementation</b>	(Diez-Canseco et al., 2015; Hallberg et al., 2014)
<b>Readiness</b>	(Khatun, Heywood, Ray, Bhuiya, & Liaw, 2016)
<b>Adoption</b>	(Chib et al., 2015; Leigh & Ashall-Payne, 2019)
<b>Acceptability</b>	(Beratarrechea et al., 2015; Feinberg et al., 2017; Lodhia, Karanja, Lees, & Bastawrous, 2016)
<b>Usability and feasibility</b>	(Vedanthan et al., 2015)
<b>Use</b>	(Beratarrechea et al., 2016; Garner, Sudia, & Rachaprolu, 2018)
<b>Adherence</b>	(Anglada-Martinez et al., 2015; Badawy et al., 2017; Bobrow et al., 2016; Leon, Surender, Bobrow, Muller, & Farmer, 2015)
<b>Effectiveness</b>	((Müller, Alley, Schoeppe, & Vandelanotte, 2016)
<b>Engagement</b>	(Barello, Graffigna, Vegni, & Bosio, 2014)
<b>Service quality</b>	(Shahriar Akter et al., 2013; Doocy et al., 2017).
<b>Inequalities</b>	(Latulippe et al., 2017; Mayberry et al., 2019; Adams, Díaz, & Molina, 2015; Kumar & Arya, 2015; Jennings & Gagliardi, 2013)

The researcher’s analysis shows that the extant MHealth literature focused on the “success or failure” of the intended outcome, with limited discussion of “unintended consequences” of the MHealth innovation. Literature analysis highlight “unintended consequences” of MHealth innovation as a research gap. The MHealth research topics focus on the “success or failure” of MHealth implementation (Figure 2.2) at individual levels, with little discussion of the “unintended consequences” at the social level.

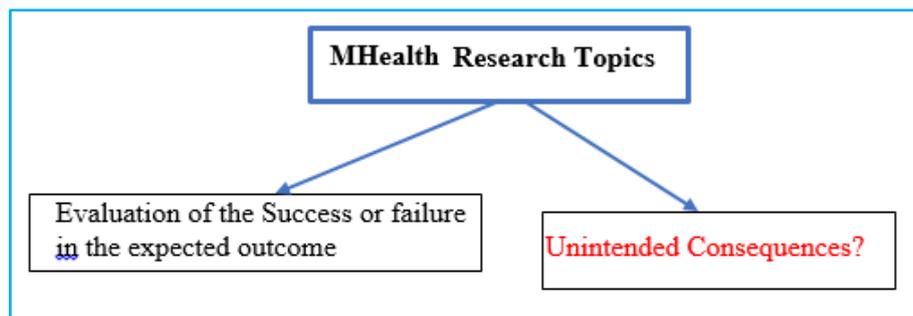


Figure 2.2 Research gap for unintended MHealth consequences (Appendix A)  
Red letters indicate gap in the literature

### 2.5.5. Main areas of health service delivery where MHealth were used

The evaluation of the MHealth literature include health service delivery where MHealth were used (Bergman, Neuhauser, & Provost, 2011; Tamrat & Kachnowski, 2012). Previous studies suggest that healthcare service delivery is “process-oriented” or characterised by various stages in the health service delivery process (Bergman et al., 2011; MacIntosh, MacLean, & Burns, 2007). Thus, the health service delivery process follows sets of repeatable activities in a “stage by stage” sequence which also corresponds to the use of various MHealth technology tools in each stage (Bergman et al., 2011; Nasi, Cucciniello, & Guerrazzi, 2015).

Studies categorise MHealth care delivery process into five main stages of the healthcare delivery (Bergman et al., 2011). Healthcare literature identify the stages or phases of the health care delivery process, i.e., main areas of health service delivery to include Prevention, Data collection, Diagnosis, Treatment, Behaviour adherence Support (Figure 2.3). The five phases of MHealth delivery process are described in the sections below.

#### 2.5.5.1. MHealth for disease prevention: Health care stage 1

MHealth for disease prevention (healthcare Process Stage 1) is the stage for “keeping healthy”, and include activities such as keeping healthy through physical fitness, good diet, clean

drinking of water, tobacco cessation etc. (Bergman et al., 2011). This includes the use of MHealth promotion messaging to communicate with patients in order to increase health awareness and promote access to health services (Leon, Schneider, & Daviaud, 2012). In addition, MHealth prevention includes the process prevention through education (Chandra, Sowmya, Mehrotra, & Duggal, 2014; Piette et al., 2012).

Several research studies show evidence of MHealth tools for disease prevention and health promotion to address inequalities targeting health education (Anderson-Lewis, Darville, Mercado, Howell, & Di Maggio, 2018) and for the prevention of HIV (Anderson-Lewis et al., 2018; Armaou et al., 2020). Also the literature shows that MHealth tools play much roles in fitness and physical exercises (Anderson-Lewis et al., 2018; Mayberry et al., 2019). The use of MHealth for prevention in stage 1 is focused on the behavioural change in physical exercise and fitness for the target population (Direito, Carraça, Rawstorn, Whittaker, & Maddison, 2017; Mayberry et al., 2019; Mendoza et al., 2017; Schoeppe et al., 2017). The use of MHealth tools include for behavioural change targeting the prevention and control of non-communicable disease (Gupta, Dixit, & Reddy, 2016; Majumdar, Kar, Kumar, Palanivel, & Misra, 2015).

#### 2.5.5.2. MHealth for data collection: Healthcare stage

This stage of the healthcare delivery process (in Figure 2.3) include the use of MHealth tools for data collection and rapid access to data for purposes of research and disease surveillance (Leon et al., 2012). Data collection involves systematic gathering, analysis, and interpretation of health data required for public health prevention programs (Schobel, Pryss, Schickler, & Reichert, 2016; Teutsch & Thacker, 1995).

Research studies also showed evidence of the MHealth tools applied in data collection for risk assessment (WHO, 2011). MHealth is used during the data collection stage to target changes in knowledge and modify behaviours of the population (Anderson-Lewis et al., 2018; Velthoven, Brusamento, Majeed, & Car, 2013; Zhang et al., 2012), especially in low and middle income countries (Du et al.; Schobel et al., 2016; Velthoven et al., 2013; WHO, 2018; Zhang et al., 2012).

#### 2.5.5.3. MHealth for diagnosis: Health care 3

The diagnosis stage of the healthcare delivery (in Figure 2.3) is the process needed to trigger the treatment phase (Bergman et al., 2011). During diagnosis the healthcare workers determine the cause of an individual's deterioration, by using diagnostic tools such as MHealth (Knoble & Bhusal, 2015; Surka et al., 2014). MHealth tools for diagnosis were used to target sexually

transmitted diseases and HIV infection in developing countries (Jarke, 2018; Kumar & Arya, 2015).

#### 2.5.5.4. MHealth for treatment: Healthcare stage 4

The treatment stage of the healthcare delivery involves “curing and caring” of patients (Bergman et al., 2011). During this stage (Figure 2.3), healthcare workers address deterioration of health by treatment using medicines, surgeries, and other treatment methods (Alam, Khanam, & Khan, 2010; Knoble & Bhusal, 2015). MHealth tools for treatment include the treatment of tuberculosis (TB) patients (Bommakanti et al., 2020), and using short message service (SMS) based interventions to target HIV/AIDS, as well as sexual and reproductive health treatment (Catalani, Philbrick, Fraser, Mechael, & Israelski, 2013; Jennings & Gagliardi, 2013; Kayima, Wanyenze, Katamba, Leontsini, & Nuwaha, 2013).

#### 2.5.5.5. MHealth for behaviour adherence support: Healthcare stage 5

“Adherence” describes the “extent to which an individual’s behaviour coincides with health-related instructions or recommendations given by a health care provider in the context of a specific disease or disorder” (Christensen, 2004). Studies show overwhelming evidence in the use of MHealth tool to support patients’ adherence to medical care regimen or recommended behaviour change therapies (Alcaraz et al., 2017; Christensen, 2004; Déglise, Suggs, & Odermatt, 2012; Martin, 2012).

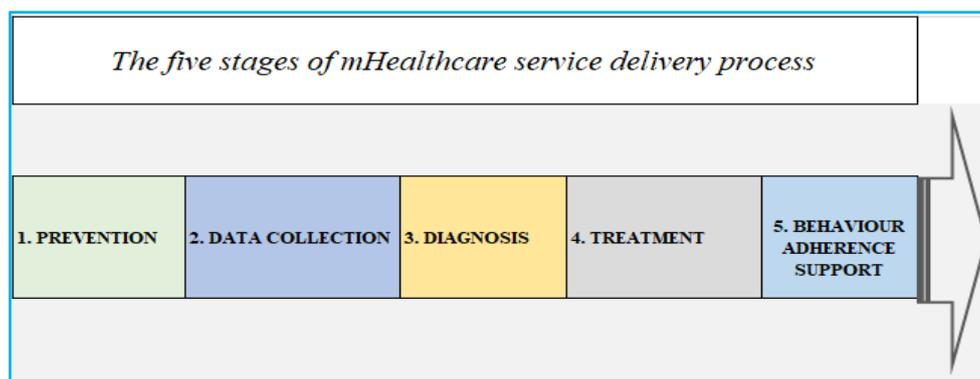


Figure 2.3 Five stages of MHealth use in health service (Appendix A)

MHealth research study shows that this healthcare stage is focused on behaviour adherence targeting prevention (Anderson-Lewis et al., 2018; Armaou et al., 2020; Nelson et al., 2016), and behaviour adherence support for treatment (Armaou et al., 2020; Barlott, Adams, Díaz, &

Molina, 2015). The literature shows there is a limited MHealth research contribution in the areas of diagnostics and treatment (Bommakanti et al., 2020; Jennings & Gagliardi, 2013).

The healthcare literature identified five stages of the health delivery process, but the extant MHealth literature are focused on the treatment of patients for adherence behaviour. Thus, there is little discussion of the use of MHealth for prevention to avoid illness. Therefore, the MHealth literature is limited in its discussion of MHealth for disease prevention (Figure 2.3).

### **2.5.6. MHealth target user categories**

The evaluation of MHealth literature was also carried out based on the MHealth user categories. Previous studies identified various categories of MHealth users (Figure 2.4) which is arranged in two main categories: (1) MHealth providers, and (2) MHealth consumers.

#### **2.5.6.1. MHealth User category: MHealth Service Providers**

MHealth providers use MHealth tools to provide service or support to patients. The literature analysis shows that MHealth providers (Figure 2.4) include physicians, surgeons, nurses, medical technicians, pharmacists, lab scientists, as well as other health workers and care givers who are trained to assist patients (Leigh & Ashall-Payne, 2019). Previous studies have identified healthcare professionals as one of the main user groups of MHealth (WHO, 2006). This category of MHealth users have the education and training which enable them to provide services to patients at the various stages of the health delivery (Organization, 2010; WHO, 2008). Health professionals in the literature is defined as those who possess medical skills to provide preventive, curative, rehabilitative and promotional health services based on an extensive body of knowledge in diagnosis and treatment of disease and management of other health problems (Gagnon, Ngangue, Payne-Gagnon, & Desmartis, 2016; WHO, 2006).

#### **2.5.6.2. MHealth user category: MHealth consumers**

The studies identified personal users of MHealth to include Patients, Individuals at risk such as the elderly, people with disabilities and low SE population (Armaou et al., 2020; Barlott et al., 2015). MHealth studies lay great emphasis on two users in the consumer category (Faiola & Holden, 2017; McCurdie et al., 2012). The MHealth consumers fall in two broad categories, the patients (Cicolini et al., 2014) and the individuals at risk of disease (Feinberg et al., 2017). The MHealth literature is dominated by research conducted for patient populations targeting treatments , and quite a few investigation involving underserved population or individuals at risk (Diez-Canseco et al., 2015; Feinberg et al., 2017). The research on MHealth consumers

target mainly the cognitive and behavioural responses of individuals to ICT events (Luxton, McCann, Bush, Mishkind, & Reger, 2011).

a. **MHealth consumers: the patients**

The MHealth literature identifies users such as patients, especially those who are chronically ill and the elderly people - over 65 of age, women in pregnancy, special need people, and discharged patients under care (Bobrow et al., 2016; Hacking et al., 2016). MHealth literature describe patients as those undergoing treatment because they have been clinically diagnosed with diseases or related symptoms by their treating physicians or health professionals (Hasandokht, Farajzadegan, Siadat, Paknahad, & Rajati, 2015). These patients remain under the care of the health professional during, and sometimes after treatment (Hacking et al., 2016).

The use of MHealth for patient populations is popular especially at the treatment stage of the health delivery process (Bobrow et al., 2016) and during the palliative care (Alcaraz et al., 2017; DeRenzi et al., 2011). The MHealth plays a very important role in medication adherence and provides great support and prevention against repeated hospital visitations (Leon et al., 2015). Several MHealth tools support patients for behaviour change, or serve as health monitoring device which helps to reduce unnecessary hospital visits (Feinberg et al., 2017).

b. **MHealth consumers: individuals-at-risk**

MHealth literature reveals another category of MHealth consumers, the “individuals at risk” (Diez-Canseco et al., 2015; Feinberg et al., 2017). The individuals at risk are not patients, however without prevention programmes, they have the potential of becoming patients soon. Most of the MHealth research are targeted to “patients”, especially, in low and middle income countries (Bobrow et al., 2016). The MHealth literature in high income countries indicate that MHealth is predominantly used for behaviour change targeting “individuals at risk” in the area of physical exercise (Diez-Canseco et al., 2015; Direito et al., 2017).

The “individuals at risk” are “vulnerable people” because they have potentials to become patients soon. The “individuals at risk” are “the medically underserved”, and those pejoratively deemed as the hard-to-reach, the subordinate group, racial/ethnic population, and the minorities (Feinberg et al., 2017; Whelton et al., 2017). The individuals-at-risk can be described as healthy people who are apparently exposed to immediate or remote danger of disease due to personal, social, economic, environmental, or other circumstances surrounding them (Feinberg et al., 2017; Whelton et al., 2017).

The individuals at risk are part of MHealth users; they are non-symptomatic individuals (Diez-Canseco et al., 2015), but are however vulnerable to health risks. Individuals at risk are exposed to risk such as chronic disease, or the combined impact of behavioural risk factors in terms of unhealthful diets, alcohol, smoking or sedentary lifestyle (Chiarini, Ray, Akter, Masella, & Ganz, 2013). Individuals at risk can be vulnerable in terms of isolation, stemming from the remoteness of their population by residential neighbourhood, or isolation from health programs (Rappaport, 1981). Also vulnerability of the individuals at risk could be associated to their lifestyle, health history or ancestry (Rappaport, 1981). Socio-economic disadvantage (Yach, Hawkes, Gould, & Hofman, 2004) or proximity to disease prevalence can be the source of immediate or future risk of communicable or infectious diseases for individuals at risk (Diez-Canseco et al., 2015). The individuals at risk also include medically underserved populations where individuals are inhibited in their abilities to avail of essential medical and health services (Jimison et al., 2008). The individuals at risk are endangered people who are sometimes described pejoratively as the hard-to-reach (McLeroy et al., 1988). This vulnerable group, the individuals at risk, or the hard-to-reach population are quite often people that are unfairly affected due to their invisibility during planning and implementation of most intervention programs (McLeroy et al., 1988). The individuals at risk are invisible in a way that even well intended health programs elude these people due to socioeconomic, racial/ethnic isolations, and other unfair but avoidable disadvantages (Fleurbaey & Schokkaert, 2009). According to McLeroy et al. (1988), this group compose of those who may be historically or currently exposed to severe health problems within a community, yet having the least access to the community powers or social resources (McLeroy et al., 1988, p. 364). The individuals at risk are mostly the poor, mainly living in rural neighbourhoods or underserved communities; they are mostly uneducated, many unemployed or underemployed, perhaps living in temporary shelters or even homeless (Phelan, Link, Moore, & Stueve, 1997; Wallerstein, 1992). The individuals at risk are sometimes ironically derided as “special need individuals”, perhaps due to complexities surrounding their physiological, behavioural, or social circumstances (McLeroy et al., 1988; Raphael, 1946; Shi & Stevens, 2005). Ironically, these hard-to-reach people, the vulnerable, the individuals- at-risk, the special need, the minorities (Gary, 2005; Ingleby, Krasnik, Razum, & Lorant, 2012; McLeroy et al., 1988; Nielsen & Krasnik, 2010; Simpson & Yinger, 2013) are quite often invisible to intervention programs. Most health delivery processes are designed to be called successful when the delivery outcome is measured

with the mainstream population without the minorities in mind (Burdine, McLeroy, & Gottlieb, 1987; Kilanowski & Ryan-Wenger, 2007; McLeroy et al., 1988).

MHealth organisational stakeholders are system owners (regulators, investors, promoters, managers) who have economic, financial, or promotional interests (Shahriar Akter & Ray, 2010b; Schweitzer & Synowiec, 2012). MHealth providers are health professionals and care workers (medical doctors, medical specialist, nurses, midwives, laboratory technicians and community health workers) (Eze, Gleasure, & Heavin, 2016). MHealth knowledge workers have responsibilities which are based on specialised body of knowledge (system designers, builders, analysts, researchers) (Eze et al., 2016; Petersen, Adams, & DeMuro, 2015). The general population (consumers) who receive MHealth services are patients and those who may benefit from preventative care) (Shahriar Akter & Ray, 2010b; Petersen et al., 2015).

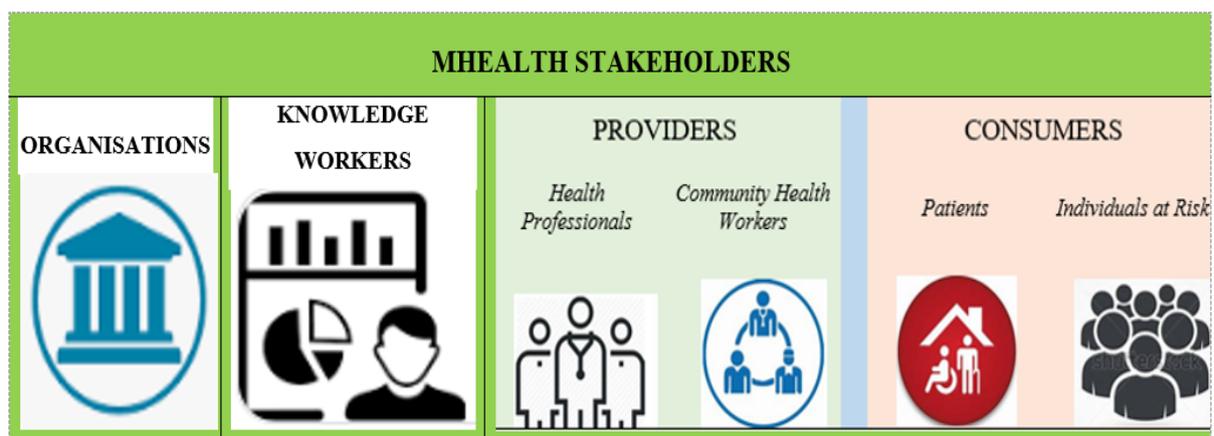


Figure 2.4 Depiction of MHealth user categories in the literature (Appendix A)

The extant MHealth literature focuses exclusively on the adherent behaviour of patients during treatment, with little discussion of disease prevention for the healthy individuals-at risk. Figure 2.4 shows that MHealth literature reveals four categories, with limited discussion of the use of MHealth for underserved, healthy individuals-at-risk.

## **2.6. Inequalities in MHealth**

### **2.6.1. Definition of inequalities in consumer MHealth**

Studies show that individuals are not equally placed to explore the advantages of MHealth. Therefore, MHealth inequalities arise due to differences in socioeconomic status which can be aggravated in a sociotechnical environment . The following sections explore some important issues surrounding inequalities in MHealth.

MHealth inequalities (as well as digital inequalities) are expansively used to refer to the notion of differences that are systematic (not random), and unfair, unjust, avoidable, and unnecessary in the application of digital services. (Arcaya et al., 2015; Graham, 2009; Gerry McCartney, Collins, & Mackenzie, 2013; Weiss & Eikemo, 2017). Inequalities in Consumer MHealth is used here to refer to the systematic differences that are unfair, unjust, avoidable, and unnecessary in the application (development, implementation and use) of consumer MHealth innovation (DiMaggio & Hargittai, 2001; Krieger, 2001). The “consumers of MHealth” refer to personal, direct, or self-users, such as individuals who are potential or current personal users of MHealth at home. These are home users of MHealth, including the personal use of portable, wireless mobile health information devices for physical activity and fitness (Organization, 2016; Pita-Barros et al., 2019). In this study, for simple identification, the “inequalities in consumer MHealth innovation” is referred to as “inequalities in MHealth” or “MHealth inequalities”.

### **2.6.2. Measures of inequalities in consumer MHealth**

Inequalities in MHealth has continued to attract increasing number of studies. The literature of MHealth inequalities show evaluation topics addressing fundamental measures such as awareness, literacy, knowledge, engagement, ownership, education, gender, etc. The studies also show that the key performance of MHealth innovation is traditionally measured in terms of the key bbenefits of MHealth, such as: access, coverage, efficacy, cost, effectiveness, etc. The overwhelming endorsement by MHealth stakeholders show the use of MHealth to complement existing healthcare infrastructure by targeting heterogeneous audience for specific health need. However, the literature does not provide coherent topology of the field of the MHealth inequalities. MHealth inequality topics provide explicit evaluative criteria in addition to the implicit factors inductively derived from the literature. Both the explicit and inductive

factors in the literature of MHealth inequalities are organised in four groups. Thus, the discussion is organised in the following four categories of argument:

- SE disparities undermine effectiveness of MHealth innovation (victim blaming ideology)
- MHealth can improve inequalities; the traditional measure: efficacy, cost-effectiveness, etc
- MHealth can expand or widen inequalities (unintended consequence)
- MHealth can both improve and widen inequalities.

#### 2.6.2.1. SE disparities undermine effectiveness of MHealth innovation

This group of literature argues that SE disparities can undermine MHealth effectiveness (Armaou et al., 2020; Bishwajit, Hoque, & Yaya, 2017; Bommakanti et al., 2020). The literature suggests that low SE characteristics can undermine the effectiveness of MHealth innovation. The researcher refers to this concept as a “victim blaming ideology” which proposes that MHealth inequalities are the fault of the victims of low SES. This argument suggests that there are further problems of the target population which renders supposedly effective MHealth ineffective. Therefore, the research suggests that some low SE population are more entrenched thereby giving rise to inequalities within unequal population. These studies suggest that MHealth implementation should be optimised and tailored to specific characteristics of low SE population, such as low literacy (Armaou et al., 2020; Bennett et al., 2012).

#### 2.6.2.2. MHealth improves inequalities: the traditional measures

Studies focusing on the traditional measures of MHealth emphasise that MHealth can improve inequalities by improving efficacy and cost effectiveness (Organization, 2011). These studies suggest that MHealth implementation target measures of success, with little or no attention to the unintended consequences on the target population. These studies suggest that MHealth can improve universal access through by improving user’s knowledge, literacy level, and encourage the participation of “population at risk” (Latulippe et al., 2017). These categories of studies show the application of MHealth to improve communication and behavioural adherence (Anderson-Lewis et al., 2018; Kumar & Arya, 2015; Mayberry et al., 2019).

These studies demonstrate the MHealth potentials to improve efficacy and cost effectiveness (WHO, 2011), they also neglect the possibility of MHealth consequences to undermine or deepen the inequalities of population at risk (Latulippe et al., 2017). For example, the introduction of MHealth can undermine the data security and user privacy (WHO, 2011).

### 2.6.2.3. MHealth expand inequalities

This category of studies suggest that MHealth potentials can expand social inequalities (Latulippe et al., 2017). The argument is that MHealth innovation can further accentuate the circumstances of the population at risk. It suggests that low income, low education and low literacy, can get worse with MHealth application (Feng & Xie, 2015; Latulippe et al., 2017).

### 2.6.2.4. MHealth is a vicious circle

This category of studies suggest that MHealth is a “vicious circle” which can intensify existing conditions in populations (Baum et al., 2012; Latulippe et al., 2017). These studies argue that MHealth has potential to improve as well as expand the inequalities for some target populations (Baum et al., 2012). Question remains on how stakeholders can mitigate the anomalous nature to avoid unintended consequences in MHealth innovation. MHealth literature focus so much on fundamental measures, addressing efficacy, cost-effectiveness, and other benefits, with little discussion of the unintended consequences of escalating inequalities.

The above arguments highlight the four divides in the MHealth debate. This aspect of the literature underscores the definition that MHealth is a derivative of Inequalities in MHealth is regarded as “socioeconomic anomalies”, with no explanation of how MHealth innovation improve, undermine, mitigate, or reinforce inequalities. Figure 2.5 illustrates the four divides in the MHealth debate, which highlights the lack of clarity.

**Table 2.2 MHealth literature is divided on issues of inequalities (Appendix A)**

<b>MHealth mitigate inequalities</b>	(Anderson-Lewis et al., 2018; Mayberry et al., 2019; Jarke, 2018; Régnier & Chauvel, 2018; Sinha & Schryer-Roy, 2018; Heitkemper, Mamykina, Travers, & Smaldone, 2017; Latulippe, Hamel, & Giroux, 2017; Nelson et al., 2016; Barlott, Adams, Diaz, & Molina, 2015; Kumar & Arya, 2015; Jennings & Gagliardi, 2013)
<b>MHealth aggravate inequalities</b>	Bishwajit, Hoque, & Yaya, 2017; Khatun et al., 2017
<b>Low se undermine MHealth</b>	Crawford & Serhal, 2020; Mayberry et al., 2019; Jarke, H. 2018; Bommakanti et al., 2020; Crawford & Serhal, 2020; (Régnier & Chauvel, 2018; Sinha & Schryer-Roy, 2018; Nelson et al., 2016)
<b>MHealth is a vicious circle</b>	Jennings & Gagliardi, 2013; Baum, Newman, & Biedrzycki, 2012

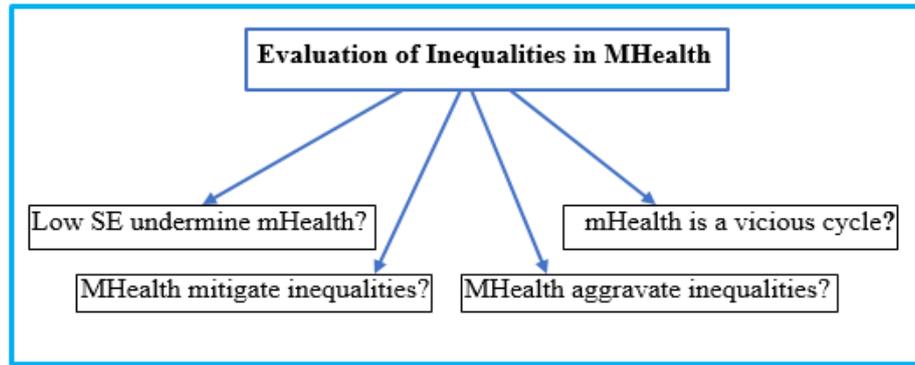


Figure 2.5 Four divisions in the MHealth debate (Appendix A)

### 2.6.3. SE minorities are the underserved consumers of MHealth

#### 2.6.3.1. Targeting low SE population- The underserved

The research literature mainly shows interventions targeting MHealth consumers, especially of low socioeconomic status, mainly ethnic minorities (Anderson-Lewis et al., 2018; Baum et al., 2012). This is the disadvantaged or vulnerable population. The low socioeconomic (SE) population are known by several names, but in this literature, we refer to this population as “underserved consumers of MHealth”, or simply the underserved population (Latulippe et al., 2017; Mayberry et al., 2019).

Studies show some characteristic differences that make the low SE population (or underserved population), vulnerable to MHealth inequalities. The differentiating characteristics of the underserved population include the following factors:

- Age, especially the older age (Bommakanti et al., 2020)
- Gender, especially women (Khatun et al., 2017; Sinha & Schryer-Roy, 2018)
- Ethnic minorities, mainly African origin (Anderson-Lewis et al., 2018; Baum et al., 2012)
- Education, without undergraduate studies (Bishwajit et al., 2017; Bommakanti et al., 2020)
- Skills and Literacy (Kreps, 2017; Lin & Bautista, 2017)
- Difficulty of English Language and communication (McGinnity et al., 2020)
- Employment, self-employed and odd jobs
- Income, low wages (Bommakanti et al., 2020)
- Household size, significant number of dependents (Clarke et al., 2021)
- Exclusion from private health/ life insurance (Anderson-Lewis et al., 2018)
- Pension Scheme, limited financial expectation (Anderson-Lewis et al., 2018)
- Health status, inherited disease, and exposure (Nabel, 2003)

- Health risk behaviour (Vlahu-Gjorgievska, Mulakaparambil Unnikrishnan, & Win, 2018)
- Location, limited access to social amenities and technology service (Bishwajit et al., 2017)
- Overcrowded accommodation in unsafe neighbourhood (Crawford & Serhal, 2020)
- Socially excluded, underserved and hard-to-reach (Jarke, 2018)
- Disintegrated, politically disconnected (Armaou et al., 2020).
- Preference for nonregimental physical activities and fitness due to cultural orientation to outdoor events (Koshoedo, Paul-Ebhohimhen, Jepson, & Watson, 2015).

#### 2.6.3.2. Low SE characteristics have sensitive impact on underserved population

The SE characteristics are seen as fundamental factors behind MHealth inequalities. Indeed, the low SE characteristics impact the underserved population and represent a sensitive topic which are not obvious to mainstream population. Understanding the sensitivity of low SE characteristics and how to address it is an important aspect in addressing inequalities.

Although the low SE factors have significant impact on the underserved population, however, the characteristics themselves do not represent any set of principles for explaining what is, why or how inequalities intensify and interfere with consumer MHealth innovation (Sutton & Staw, 1995). Obviously, low SE factors weigh disproportionately against the “underserved” but these do not explain how low SE factors aggravate inequalities in MHealth environment (Crawford & Serhal, 2020; Wu et al., 2021).

#### **2.6.4. Low SE population share common vulnerabilities with ethnic minorities**

MHealth studies particularly focus on low SE populations as the main target users of MHealth (Anderson-Lewis et al., 2018; Baum et al., 2012). These studies also show that the individuals at risk and the low SE populations share common characteristics with the people of African background (PAB) in Europe (Agyemang et al., 2016; Giménez-Gómez, Walle, & Zergawu, 2019). The common characteristics of low SE populations and the PAB include the factors presented in the sections below:

##### 2.6.4.1. Ethnic minorities are unequal in population and power

Ethnic minority populations share low SE characteristics which associate them to inequalities in MHealth (Anderson-Lewis et al., 2018; Baum et al., 2012). With significantly more people of African origin moving outside of their continental origin to Europe and the USA, the western world continues to be ethnically and culturally diverse (Agyemang et al., 2015), with the African population in diaspora becoming the minority within the mainstream white population

(Wickramage, Vearey, Zwi, Robinson, & Knipper, 2018). For example, the PAB across Europe are the minorities when compared to the dominant mainstream white population (Agyemang, Bhopal, & Bruijnzeels, 2005; Semyonov & Glikman, 2009). Studies show that PAB minorities are remarkably subordinate, or identified for their limitations of power in society, disconnection, or diminished status some of which result from prejudices, relegation and discrimination or miscommunication (Semyonov & Glikman, 2009). The PAB in diaspora remarkably brownish, tan and different in social and cultural identity (Hine, Keaton, & Small, 2009). Also, there is no up to date information showing evidence of invisibility and vulnerability of the PAB in contrast to the mainstream white population (Purdie-Vaughns & Eibach, 2008). The invisibility and vulnerability of PAB raise more questions to be addressed (Sasse & Thielemann, 2005; Wolff, 2009).

#### 2.6.4.2. Unequal in education, language, and communication

Studies in MHealth inequalities referred to low education as one of the factors that give rise to inequalities (Bishwajit et al., 2017; Bommakanti et al., 2020). The PAB minorities are quite often identified with vulnerabilities such as low education, low skills, unemployment, social and cultural differences, political isolation, and other socioeconomic disadvantages (Malmusi, Borrell, & Benach, 2010; Nielsen & Krasnik, 2010).

Low literacy and low skills of PAB population is an important factor in the study of inequalities in MHealth. Studies show the rising number of PAB and other ethnic minorities who are increasingly exposed to MHealth inequalities due to limitations in literacy and skills (Coleman, 2006). Little is known about the minority populations and their inequalities in MHealth and other digital inequalities (Kulu & Hannemann, 2016).

Disparities in language and communication is a major factor implicated in MHealth inequalities (Jarke, 2018). Again, the PAB minorities are characterised by their unique differences in language, communication, behaviour, culture, colour, population, et cetera, that easily mark them out of the mainstream population (Kumar & Arya, 2015). Studies show that ethnicity, language and cultural differences are factors that complicate behavioural risk patterns and lifestyle choices of PAB (Kawachi, Daniels, & Robinson, 2005; Gerry McCartney et al., 2013).

#### 2.6.4.3. Sensitivity of identity

The added impact of socioeconomic disadvantages of class, ethnicity/race and minority usually combine to exacerbate PAB differences and complexities . Although low SES accounts for

much of the observed differences, oftentimes existing disadvantages of PAB attract racism and social stigma, or systemic isolation that adversely affect MHealth application . Studies characterise the PAB with numerous identities, such as “Afro Europeans” (Van Deventer & Thomas, 2011), “Black Europeans”, and “African diaspora” (Brown, 2009; Hesse, 2009; Nimako & Small, 2009). Sometimes the PAB are called migrants, or refugees (Teitelbaum, 1984), however, some of the PAB began their life in the European continent as doctors, engineers or experts, not as refugees (Arthur, 2016; De Haas, 2008; Grillo & Mazzucato, 2008).

#### 2.6.4.4. Vulnerable health status

Health status of the low SE population was indicative of their vulnerability to MHealth inequalities . Studies in the United States of America and Europe show that race and ethnicity predict the differences in health between ethnic minorities and the mainstream population (BeLue et al., 2009b). For example, studies show that cardiovascular disease, diabetes, stroke, poor dietary habits, and other risk factors are associated with populations of sub-Saharan Africa descent living in Europe (BeLue et al., 2009b). Again, reasons for the high risks of chronic disease associated with people of African descent remain so far under debate, however the emerging data show that chronic disease awareness and prevention is very low among PAB (Behera, Winkleby, & Collins, 2000; BeLue et al., 2009b; Jha et al., 2013; Kayima et al., 2013). Furthermore, there is limited data on the health of PAB despite the rising population across Europe, and more importantly the high risk of chronic disease within the group (BeLue et al., 2009b; Kawachi et al., 2005). The vulnerability of PAB across Europe raises several concerns which is aggravated by the lack of data on their health (Rechel, Mladovsky, Ingleby, Mackenbach, & McKee, 2013).

Equal opportunity for health requires to address the current lack of health data on the prevalence of diseases among PAB across Europe (Agyemang, Addo, Bhopal, de Graft Aikins, & Stronks, 2009; Vandenheede et al., 2012). As a comparison of the health of mainstream population, the PAB health data require update across Europe (Ingleby et al., 2012; O’Donnell et al., 2016). Therefore, MHealth is a helpful means for targeting underserved populations (BeLue et al., 2009b; Kawachi, Subramanian, & Almeida-Filho, 2002). Furthermore, each of the five stages of the healthcare process can be improved by leveraging MHealth in targeting the underserved population (Sallis, Owen, & Fisher, 2015; Thornton et al., 2016).

#### 2.1.1.6 High mortality rate due to chronic disease prevalence

High prevalence of chronic diseases among low SE population was the focus of studies using MHealth interventions in developing countries (Armaou et al., 2020; Jarke, 2018). Studies show the difference in the social and economic life of migrants who arrive from low or middle income countries in comparison with economically developed countries (Patel & Bhopal, 2007; Vandenheede et al., 2012). The studies highlight that migrant mortality from chronic diseases such as diabetes mellitus and high blood pressure are different for various PAB ethnicity across Europe (Vandenheede et al., 2012). Furthermore, mortality associated with chronic diseases are higher in migrant groups for whom the current country of residence is economically more affluent than the country of origin (Patel & Bhopal, 2007; Vandenheede et al., 2012). For example, research findings from Britain reported high incidence of hypertension among people of Afro- Caribbean descent (Vandenheede et al., 2012). Also results of mortality from ischaemic heart disease was highest in men and women born in the Indian subcontinent, showing that young Indian men suffered higher risk (Vandenheede et al., 2012) above the mainstream white British population. Similar reports identified other groups with high mortality, such as the Irish, Scottish, and Polish born immigrants who reside in Britain (Vandenheede et al., 2012). The report shows that migrants living Britain who are born in high income countries, from the Western Europe and the United States recorded low death rates below the white mainstream population in the United Kingdom (Vandenheede et al., 2012). Studies also show that PAB across Europe are especially vulnerable due to socioeconomic and inherited disadvantages of high incidence of chronic diseases, which result in high rate of early mortality (Balarajan, 1991; Kawachi et al., 2005; Vandenheede et al., 2012).

#### 2.6.4.5. Political exclusion

Studies show that low SE characteristics effect the decision of populations in several ways including political participation (Brady, Verba, & Schlozman, 1995; Leighley & Vedlitz, 1999; Scott & Acock, 1979). So many minorities are traditionally disengaged from political participation, and disconnected from access to education and health (Winkleby, Jatulis, Frank, & Fortmann, 1992). Low SE vulnerabilities also result to unemployment and poor living standard which impact decisions of lifestyle choices, dietary options, and participation in physical activities or sedentary lifestyle (Adler, Boyce, Chesney, Folkman, & Syme, 1993). The vulnerabilities of the low SE population adversely affect families and aggravate life for those living with obesity, addiction, dietary, and other challenges (Dilworth-Anderson, 1992).

#### 2.6.4.6. Unemployment and low household income

Unemployment and low household income are important aspects of socioeconomic disadvantages of PABs (Jeongeun Kim & Park, 2012; Paturot, Mellbye, & Brys, 2013) Limited resources also impact PAB decisions about health and life insurance, government pensions and benefit schemes which would have normally benefited the group (Schechter et al., 1994).

#### 2.6.4.7. Vulnerable location, accommodation, and social interaction

The vulnerabilities of low SE population also affect their decision in terms of residential accommodation, where to live and how they live. Minorities live mainly in crowded areas and crowded accommodation (Crawford & Serhal, 2020). The prevailing circumstances during the COVID-19 pandemic reveal that low SE families are most affected in terms of crowded accommodation and difficulties to isolate or even access medical treatment (Crawford & Serhal, 2020). Low SE population have limited social interaction and activities that require time off work, including the use of internet and social media (Wickramage et al., 2018). The PAB are also adversely affected by the perception of “being different” from the dominant mainstream population (Marmot, Ryff, Bumpass, Shipley, & Marks, 1997; Navarro & Shi, 2001).

#### 2.6.4.8. Characteristics of low SE individuals and behaviour change targets

Many of the research literature blames the bad behaviour of patients, with little attention to the system and the environmental factors which are fundamental sources of bad behaviour. MHealth research argues that inequalities are fundamentally a socioeconomic phenomenon, without further explanation of how MHealth innovation and other sociotechnical factors aggravate inequalities for the population at risk (Figure 2.6)

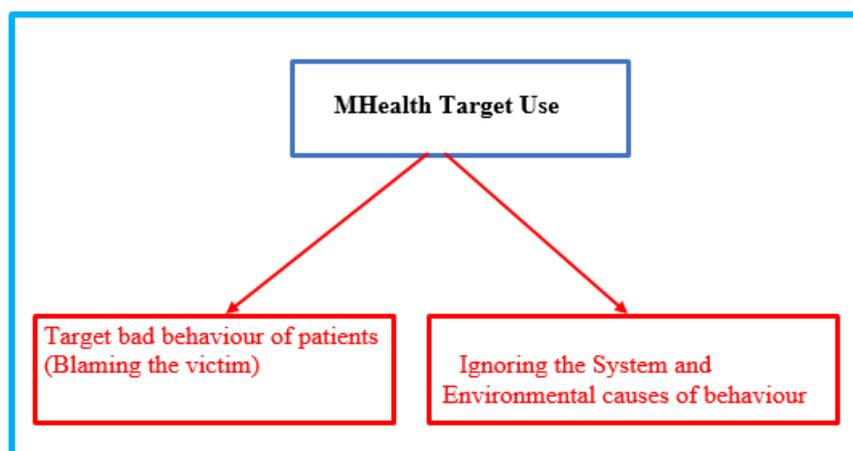


Figure 2.6 MHealth as a tool to address the risk behaviour of patients  
Red letters indicate gaps in the literature

## 2.6.5. Limitations in the current state of MHealth research

### 2.6.5.1. Research methodology used- quantitative, qualitative, or mixed method

This literature review also assessed the characteristics of the studies in terms of the methodologies of research design for the MHealth inequalities. Several methodological limitations were identified in the studies of inequalities in MHealth. Most of the studies were literature reviews (Anderson-Lewis et al., 2018; Armaou et al., 2020; Heitkemper et al., 2017; Jarke, 2018; Mayberry et al., 2019).

The dominant research methods are quantitative, qualitative, and mixed methods of approach. However, the literature reviews were mainly focused on intervention studies (Bommakanti et al., 2020; Nelson et al., 2016). Most of the studies did not clearly specify any of the paradigmatic underpinnings, while very few identified the use of quantitative research design (Bishwajit et al., 2017; Khatun et al., 2017). The quantitative research designs are few in number (Baum et al., 2012; Crawford & Serhal, 2020; Sinha & Schryer-Roy, 2018). Quite a few of the studies applied the mixed method research designs (Barlott et al., 2015; Régnier & Chauvel, 2018) while one of them was a narrative article (Kumar & Arya, 2015). The limitations in the research methodology indicates the predominance of intervention studies with little discussion of the paradigmatic underpinning in terms of ontological, epistemological, and methodological position of the researcher. Figure 2.7 illustrates the three areas of the research methodology; however, some literature remains unclear about the methodology applied.



Figure 2.7 Predominance of intervention studies without details of method applied

### 2.6.5.2. Theory building and theory testing

Quite few of the research (4 of the 24) studies based their research design and evaluation on theoretical grounding (Sutton & Staw, 1995). Very limited number of research involved theory building (Bishwajit et al., 2017; Bommakanti et al., 2020; Crawford & Serhal, 2020; Khatun et al., 2017) while one of them was a theory testing research (Sinha & Schryer-Roy, 2018). Therefore, methodological approaches focus on intervention studies with limited number of quantitative and qualitative research methods, and especially with limited number of theories to describe, explain or predict inequalities in MHealth

The research literature shows limited use of theory building or theory testing (Figure 2.8), and limited discussion of the conceptualisation of theoretical constructs and their relationships.

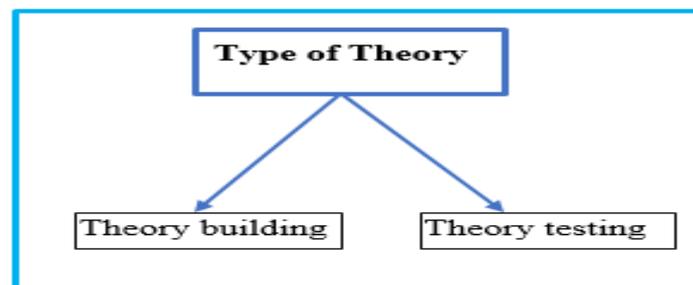


Figure 2.8 MHealth interventions present no clarity of testing or building theory

### 2.6.6. Summary of research gaps identified in the MHealth literature

The MHealth research literature reveals several limitations in its research efforts. Research gaps highlight limitations in its research focusing especially on treatment adherence support for patients, thereby doing less for health promotion and prevention. Similarly, MHealth service delivery focuses on two stakeholders; the providers and patients, thereby paying little attention to those who are vulnerable individuals-at-risk (Figure 2.4). In other words, limitations of the MHealth studies address low socioeconomic characteristics and behavioural change. MHealth studies reveal some methodological limitations, including lack of clarity of the intervention methods. Also, there are four divides in the MHealth debate which exposes a gap in the MHealth studies. Table 2.2 is a collection of the research gaps identified in the MHealth literature.

Table 2.3 Compilation of research gaps in the MHealth literature

Collection of Research Gaps in the MHealth study		
Evaluation criteria	Discussion focus	Research gap
<b>Research topics</b>	Intervention success or failure	Little discussion of unintended consequences
<b>Stages of health service delivery</b>	Outcome of treatment of patients at individual level of analysis	Little discussion of MHealth inequalities for prevention and health promotion especially at social level of analysis
<b>Health service providers use of MHealth</b>	Target consumers for behaviour change	Little discussion of the sociotechnical environment of the MHealth ecosystem which cause and sustain as sources of inequalities
<b>Target audience</b>	Focused on low SE characteristics and risk behaviours as sources of inequalities	No explanation of the ways by which MHealth innovation escalate and sustain new patterns of inequalities
<b>Research methodology</b>	Intervention studies	No clarity of paradigmatic underpinnings and methodological choices in terms quantitative, qualitative, or mixed method
<b>Limited in theory</b>	Intervention process	No clarity of theoretical underpinnings in terms of theory building or theory testing
<b>Nature of MHealth Inequalities</b>	Four divides on the fundamental nature of MHealth inequalities	Debate highlights the lack of clarity on the fundamental nature of inequalities in consumer MHealth

## 2.7. Chapter Summary and Conclusion

Chapter 2 presents the review of the MHealth literature with the definitions of Health information technology (HIT), eHealth, and MHealth. The literature review highlights the ubiquitous characteristics of MHealth and identifies the evaluative criteria used in the review process.

The evaluation of the current state of consumer MHealth literature reveals the gaps in the MHealth study, which also impose various challenges to MHealth stakeholders. Among other factors, the chapter reveals “a limited discussion of the escalating MHealth inequalities”. The review further reveals that MHealth inequalities are fundamentally addressed as a socioeconomic phenomenon, without further explanations how sociotechnical factors reinforce

and aggravate inequalities. The chapter shows that the underserved consumers of MHealth present common vulnerabilities connecting MHealth inequalities and the ethnic minority population of the PAB in the ROI.

The literature review focuses on the research gaps which underscores the research objective of this study; “to explore the antecedents of inequalities in consumer MHealth innovation for the people of African background (PAB) in the Republic of Ireland (ROI), and to develop IS framework to mitigate inequalities in consumer MHealth innovation”. The research strategy for this investigation is the subject of the methodology chapter (chapter 3).

## **CHAPTER 3.**

### **RESEARCH METHODOLOGY**

#### **3.1. Introduction**

Chapter three presents the research design and the details of the research strategy in this study. In section 3.2, the research objective, and the research questions (formulated in the literature review) are restated as the starting points for the methodology chapter. A review of the existing paradigms in information systems research is presented in section 3.3; and followed by a suitable paradigm for the MHealth research (section 3.4). The methodological choice for the research design in this study is presented in section 3.5, which supports a qualitative research approach with a multiple case study method. Section 3.6 contains the data gathering protocols, the documentation of the research instruments, and the data sampling strategy used in this study.

The collection of data (section 3.7) presents the demographic surveys, and the use of TAP, RPD, and the in-depth interviews in the research field. The field work is followed by data analysis process by the use of the grounded theory (section 3.8) and supported by a validation of the qualitative analysis in this research. Section 3.9 concludes with a summary of the methodology process and the outcome of the grounded theory process used in this study.

#### **3.2. Research Objective, and Research Questions**

The identification of a suitable research objective is critical in this research. (Jenkins, 1985; Nunamaker Jr, Chen, & Purdin, 1990). Based on the review of the literature in chapter 2, in the following sections the research objective is well-defined, clear of any ambiguity, concise and accurate to guide the research study (Doody & Bailey, 2016; O'leary, 2004).

##### **3.2.1. Research Objective:**

The research objective is to explore the antecedents of inequalities in consumer MHealth innovation for the people of African background (PAB) in the Republic of Ireland (ROI), and to develop IS framework to mitigate inequalities in consumer MHealth innovation.

Three research questions are germane to address the research objective. In section 3.2.2 this research presents the three research questions and highlights the background information that underscores the relevance of these questions.

### **3.2.2. Research Questions 1, 2, and 3.**

#### **3.2.2.1. Background to the research questions.**

Although consumer MHealth innovation is an integral part of a broader interpretation to address disparities in health, however, its application concomitantly evolves new patterns of inequalities that adversely exacerbate the health gap among low SE populations. Researchers, practitioners, and other health information systems' stakeholders face the dilemma of reconciling the perplexing, and often contradictory rise in health inequalities in their commitment to implement consumer MHealth innovations.

MHealth studies show that inequalities are fundamentally addressed as a derivative of socioeconomic phenomenon without further explanation of how technology and other mechanisms reinforce and aggravate its patterns (Arcaya et al., 2015; Braveman & Tarimo, 2002; Graham & Kelly, 2004). Therefore, a theoretically grounded empirical research is required to develop more insights into the concept and the relationships among the constructs, as well as the understanding to mitigate inequalities in MHealth (Hsieh et al., 2008).

Consequently, research question 1 is formulated to address the lack of consensus on important concepts relating to inequalities in consumer MHealth innovation. Without the fundamental theoretical constructs, MHealth researchers, managers, as well as other MHealth stakeholders face the dilemma of reconciling the perplexing, and often contradictory rise in inequalities in their commitment to implement consumer MHealth innovations. As part of this inquiry, research question 1 (section 3.2.2.2) emphasises the need for conceptual clarity of the antecedents of inequalities in consumer MHealth innovation.

#### **3.2.2.2. Research Question 1**

- What are the antecedents of inequalities in consumer MHealth innovation for the people of African background (PAB) in the Republic of Ireland (ROI)?

Research question 1 is exploratory in nature and designed to identify the antecedent factors associated with inequalities in consumer MHealth for the people of African background (PAB) in the Republic of Ireland (ROI). This research question seeks to explore the building blocks or constructs of MHealth inequalities. This aspect of the research question seeks to develop the

factors that help to explain inequalities in MHealth (Gregor, 2006). The challenges of MHealth inequalities will remain misunderstood and misapplied if the foundational theoretical concepts are undefined.

#### 3.2.2.3. Research Question 2

- What are the relationships between the antecedent factors and inequalities in consumer MHealth innovation for people of African background (PAB)?

Research Question 2 is designed to establish the relationship between the inequalities in consumer MHealth and the antecedent factors. The relationships among the factors leads to theory (Gregor, 2006). The resultant theory helps to elaborate the relationship among the factors which can help to explain or partially predict inequalities in MHealth (Kaiser & Presmeg, 2019, p. 83). .

#### 3.2.2.4. Research Question 3

- What IS framework can we develop to mitigate inequalities in consumer MHealth innovation for people of African background (PAB)?

Research question 3 is designed to develop IS framework for addressing inequalities, not as a behavioural anomaly of low socioeconomic individuals, but as a holistic outcome of stakeholders' interest and activities in a sociotechnical environment of the MHealth ecosystem. Research question 3 leads to the development of MHealth equitable service framework, for addressing inequalities in consumer MHealth innovation for PAB.

Especially, the developing of MHESF unveils a broader understanding that inequalities in MHealth are not about risk behaviour of low socioeconomic individuals alone, but a phenomenon rooted in the complexities of the stakeholders' activities and the MHealth ecosystem. (Krohn, 2020; Nair, 2019; Serbanati, Ricci, Mercurio, & Vasilateanu, 2011). The MHealth ecosystem is a type of IS (Iivari, Hirschheim, & Klein, 1998; Orlikowski & Baroudi, 1991).

Again, inequalities in MHealth is the notion of systematic differences that are unfair, unjust, unnecessary, and avoidable in the application (development, implementation and use) of consumer MHealth innovation (DiMaggio & Hargittai, 2001; Krieger, 2001; G McCartney, Popham, McMaster, & Cumbers, 2019). The development of an IS framework aims to mitigate inequalities, and to embrace equity in the application of MHealth innovations (Gregor, 2006).

### **3.3. Research Philosophy and Competing Paradigm in IS**

This section reviews the existing literature on the research philosophy (section 3.3.1) and the paradigm in IS (section 3.3.2)

#### **3.3.1. Scientific Research Philosophy**

Scientific research philosophy defines the researcher's strategy for the formulation of the research question, data collection, and analysis from which new knowledge is obtained (Žukauskas, Vveinhardt, & Andriukaitienė, 2018). Every researcher is guided by a choice of philosophical approach, which are the researcher's paradigm or basic assumptions that define the ontology, epistemology and methodology that guides the study. A paradigm is a framework, assumptions or a set of basic beliefs (or metaphysics) that defines for its holder the nature of the world, and the individuals place in it (Guba & Lincoln, 1994). Paradigm defines the researcher's worldview, and a range of possible relationships to that world and its parts.

A paradigm is akin to “a set of analytic lenses” or “viewing glasses” to guide the researcher in a relevant way, to understand reality during investigation (Guba & Lincoln, 1994). Research paradigms operate under different sets of human assumptions and provide alternative frameworks to help researchers in their investigation (Lincoln, Lynham, & Guba, 2011). The building blocks of a paradigm comprise of the ontology, epistemology, and the methodology which are assumptions that guide a field of study (Guba & Lincoln, 1994; Kuhn, 2012). The ontology, epistemology, methodology and methods, determine how the evidence and the findings properly address the research objective (Neuman, 2011; Scotland, 2012). At the onset of a research investigation, it is important for researchers to understand and identify the underlying ontology, epistemology and methodology that are suitable to be applied (Creswell & Creswell, 2017; Saunders, Lewis, & Thornhill, 2009; Scotland, 2012). A reflective approach of the paradigms suggest a position which captures both the social and technical interaction between information technology, people and organisations (Orlikowski & Baroudi, 1991; Orlikowski & Robey, 1991).

#### **3.3.2. Competing Research Paradigms in IS**

Positivism and Interpretivism are two complementary and competing paradigms found in IS research (Fitzgerald & Howcroft, 1998; Khazanchi & Munkvold, 2003). The discussion in this research is framed in terms of the ontology, epistemology, and methodology assumptions of Positivism and Interpretivism. Each of these paradigms is defined by its stance or choice of

ontology, epistemology, and methodology in IS research represented in table 3.1. Further description of ontology, epistemology, and methodology are presented in section 3.3.2.1, 3.3.2.2, and 3.3.2.3.

**Table 3.1 Alternative paradigms of IS inquiry**

Competing paradigms in IS inquiry. This Table is adopted from Guba, 1994, p.109; 2011, p.165; Fitzgerald & Howcroft, 1998, and adapted for this study.		
<b>Basic belief systems, assumptions or worldview that guide the investigator in choices of ontology, epistemology, and method</b>	Positivism	Interpretivism (Naturalistic inquiry)
<b>Ontology:</b> Cognition, perception, awareness, or view of: <b>the form and nature of reality</b>	naïve realism-- external, objective, independent, meaning solely resides in objects	Relativism-- local and specific constructed realities
<b>Epistemology:</b> <b>View of what constitutes acceptable knowledge</b> - how knowledge can be created, acquired, or apprehended and communicated	objectivism: observable reality provides credible data, facts independent of researcher. etic/outsider	subjectivist/transactional; created findings  emic/insider
<b>Methodology:</b> View of the rules of preference for <b>suitable investigation process</b> ; including method. Means by which knowledge is arrived at to inform research. Research methodology defines the rules of how the researcher systematically designs a study to ensure valid and reliable result that addresses the research objective and questions. Answer to questions “why, what, from where, when and how data is collected & analysed.	Experimental/ manipulative; verification of relationships mainly quantitative, exploratory, Deductive – from general, theory, to specific	qualitative  inductive - conceived from specifics in the observations of data to a broader generalization of theory

### 3.3.2.1. Ontology

Ontology is the assumption of the form and nature of reality, how things are and how things really work (Crotty, 1998, p. 10; Scotland, 2012). Ontology defines the values and meaning of what constitutes reality (Guba & Lincoln, 1994; Scotland, 2012). In other words, ontology represents assumptions of the form and nature of reality with regard to the phenomenon or “how things really are and how things really work”. (Guba & Lincoln, 1994; Lincoln et al., 2011). The researcher’s ontological question clarifies the assumptions of what can be known or the form and nature of reality to apprehend the phenomenon (Guba & Lincoln, 1994).

### 3.3.2.2. Epistemology

Epistemology is a set of assumptions of the nature and form of knowledge, and assumptions for evaluating knowledge claims (Guba & Lincoln, 1994, p. 108; Scotland, 2012). The epistemology assumptions refer to “what constitutes acceptable knowledge” and “how knowledge can be created, acquired and communicated” (Guba & Lincoln, 1994, p. 108). Epistemology assumptions also represent the nature of the relationship between the researcher and the phenomenon to be investigated (Guba & Lincoln, 1994; Lincoln et al., 2011).

### 3.3.2.3. Methodology

Methodology represents the procedure by which knowledge is generated in a research (Ryan, 2006). Research methodology defines the strategy, plan of action or logical structure of the inquiry, encompassing the ontology, epistemology, methodology and method to be applied (Crotty, 1998, p. 3; Scotland, 2012). By following a particular methodology the inquirer selects a suitable investigation plan to obtain unambiguous evidence that informs research, or answers the questions about what can be known (Ryan, 2006). Methodology is the procedure used to addresses “why, what, from where, when and how” data is collected and analysed (Guba & Lincoln, 1994, p. 108).

### 3.3.2.4. Method

As part of the methodology, the method refers to “specific technique and procedure” used for the collection and analysis of data (Crotty, 1998, p. 3; Scotland, 2012). Research method is quantitative, qualitative or mixed depending on the type of data required to address the research questions (Crotty, 1998, p. 3; Scotland, 2012). It is relevant to note that any paradigm can use quantitative or qualitative data collection and analysis (Guba & Lincoln, 1994).

## **3.3.3. Positivism: Scientific Inquiry**

Positivism is the assumption that the world conforms to fixed laws of causation (Fitzgerald & Howcroft, 1998). The emphasis of positivism is objectivity, measurement, and repeatability (Fitzgerald & Howcroft, 1998; Khazanchi & Munkvold, 2003). However, it is soon revealed in later sections that the scientific methods of the positivists are often not ideal for the natural and social world (Orlikowski & Baroudi, 1991; Scotland, 2012).

### 3.3.3.1. Positivism: Ontology

The positivist ontology is “realism” commonly called “naïve realism” (Fitzgerald & Howcroft, 1998). Realism defines what can be known, from “real existence” and how things really work

in real world (Guba & Lincoln, 1994). For the realist, reality consist of pre-existing tangible structures which are independent of an individual's cognition and discoverable in the external world (Fitzgerald & Howcroft, 1998; Guba & Lincoln, 1994; Lincoln et al., 2011).

#### 3.3.3.2. Positivism: Epistemology

The Positivists' epistemology is the notion of objectivism (Guba & Lincoln, 1994). Positivist researchers assume an impartial position in their attempt to discover absolute knowledge about objective reality which exist outside themselves (Guba & Lincoln, 1994; Scotland, 2012). The epistemology assumptions are related to the ontology assumptions of "external reality" (Guba & Lincoln, 1994). External reality maintains that meaning solely resides in objects, so that the aim of the researcher is to discover the intrinsic meaning of a pre-existing phenomenon outside themselves (Crotty, 1998, p. 8; Scotland, 2012). Positivist researchers understand external phenomenon under investigation by maintaining an independent status, and remaining as separate entity (Guba & Lincoln, 1994; Scotland, 2012). Objectivism tend to deny any relationship between the actors and the knowledge being pursued (Ryan, 2006). Positivist paradigm is commonly applied in natural sciences to support descriptive statements of scientific propositions, and to generate theories based on objective data and facts (Crotty, 1998, p. 8; Scotland, 2012). The objective investigator focuses on observable reality without attempt to influence it or being influenced by it. Objective research is deemed to be value-free research, without political, historic or researcher's influence (Hammersley, Gomm, & Foster, 2000; Lincoln et al., 2011). Positivists disregard non-observable sources such as human experiences, reasoning or interpretation which are seen as unsuitable for scientific enquiry (Fox, 2008). The positivist epistemology is unsuitable for sociotechnical phenomenon such as MHealth

#### 3.3.3.3. Positivism: Methodology

Positivist methodology uses experimental methods which emphasise measurement (quantification) and analysis for explaining causal relationships between variables and outcomes (Creswell, 2009, p. 7; Scotland, 2012). Positivist methodology uses deductive approach to formulate laws as grounds for theoretical prediction and generalisation (Creswell, 2013; Scotland, 2012). In order to understand relationships, a scientific researcher uses control measurements in the form of an experiment or observation that is designed to minimise the effects of other variables (control variables) while allowing the independent variable to be tested (Guba & Lincoln, 1994; Scotland, 2012). The scientific paradigm of the positivism seeks predictions and generalisations which rely on quantitative (quantity measurement) methods of

data collection and analysis. Quantitative methods emphasise objective measurements of large samples for a broader representation of data from sources such as surveys, closed ended questionnaires, for statistical, numerical or mathematical analysis (Fitzgerald & Howcroft, 1998; Scotland, 2012). Positivists claim that their methodology is rigorous and the knowledge generated are value neutral (Scotland, 2012).

The validity of a quantitative research instrument is defined by its capability to capture what it was designed to measure (Golafshani, 2003; Joppe, 2000). Validity ensures the truth or correct descriptions, interpretations, or conclusions about a phenomenon. It also considers whether methods, approaches, and techniques used in the study properly relate to what is being explored. Reliability is premised on the notion of uniformity or standardization in what is being measured, and consistency in the methods to capture what is being explored. Reliability of a research instrument ensures that the research process and result are consistent overtime and replicable under a similar methodology (Golafshani, 2003; Joppe, 2000).

#### **3.3.4. Interpretivism: Naturalistic inquiry**

The interpretivist paradigm claims that knowledge is constructed in the mind of the individual or group (Schwandt, 1994; Walsham, 1995). Interpretivist researchers begin with individuals and set out to interpret or understand the meanings that humans attach to their actions and the world around them (Cohen, Manion, & Morrison, 2013). The interpretivist assumes that “learning is a process of constructing meaning” and making sense of the world through experience. The endeavour of the interpretive paradigm is to understand the subjective world of human experience and to maintain the integrity of the phenomena under investigation (Cohen et al., 2013). According to the interpretivist assumption, understanding or “subjective meaning” are social constructions connected to the intentionality, thoughts, and motivations of the human subjects under study (Hovorka & Lee, 2010). Thus, “understanding is the type of knowledge gained from determining the meanings, categories, and symbols” which humans attach to actions, knowledge, and systems, which are developed, not discovered (Hovorka & Lee, 2010)

In the naturalistic inquiry, some authors apply the word “interpretivism” and “constructivism” synonymously, to have the same meaning (Bodner, 1986; Guba & Lincoln, 1994; Lincoln et al., 2011). However, other authors draw a thin line between interpretivism and constructivism, which is said to be “of more recent vintage” than interpretivism, and draws closer to the “natural science of the social” (Holstein, Gubrium, Denzin, & Lincoln, 2013; Schwandt, 1994).

Both positivism and interpretivism share the general framework for naturalistic inquiry, and “understanding the complex world of lived experience from the point of view of those who live it” (Fitzgerald & Howcroft, 1998; Schwandt, 1994). Some authors posit that interpretivism stems from the German intellectual tradition of hermeneutics and the “understanding” (*Verstehen*) of the “meaning” of social phenomenon, while constructivism offers a new conceptualisation in terms of its purpose and aim of the human inquiry (Holstein et al., 2013; Schwandt, 1994). These authors believe that persuasion of constructivism is more inclined to notions of “objectivism, empirical realism, objective truth, and essentialism” (Schwandt, 1994).

#### 3.3.4.1. Interpretivism: Ontology

The ontology assumption of Interpretivist is relativism, which sees the world from an individual subjective constructions (Alharahsheh & Pius, 2020; Hovorka & Lee, 2010). There is no universal truth for the interpretivist because realities are subjectively constructed in the mind of individuals or groups, which are based on their experiences and understanding of the world (Fitzgerald & Howcroft, 1998; Scotland, 2012). Subjective reality is individually constructed by using language to mould human experiences through conscious interaction with the world, through the senses (Scotland, 2012). Therefore, the interpretivist researcher’s approach is to delve deep into the direct evidence of the events, behaviour or phenomenon in order to understand and interpret the situation by adopting “permissive neutrality” (Alharahsheh & Pius, 2020; Fitzgerald & Howcroft, 1998).

#### 3.3.4.2. Interpretivism: Epistemology

The Interpretivists’ epistemology is subjectivism (Fitzgerald & Howcroft, 1998; Scotland, 2012). Subjectivism is the claim that the existence of real world phenomena is not independent of our human knowledge of it (Grix, 2018, p. 72; Scotland, 2012). Meaning for the subjectivist is not discovered, instead, it derives from the interaction between human consciousness with phenomenon, and the use of language for construction and identification of human experience (Scotland, 2012). Different people may construct meaning in different ways, however, sometimes there is a consensus of meaning which may derive from common ideologies, or based on shared social, cultural or historical context (Scotland, 2012).

#### 3.3.4.3. Interpretivism: Methodology

Interpretivists’ methodology aims to understand phenomenon from an individual’s subjective point of view which is relevant to the contexts of the individual (Creswell, 2009, p. 8; Guba &

Lincoln, 1994; Scotland, 2012). Interpretive methodology includes case studies, or in-depth investigation of individuals or group, of ongoing events over time (Scotland, 2012). Interpretive methodology includes phenomenology which involves direct personal experience of events; hermeneutics, which extracts deep meanings from language, and ethnographic study of cultural groups over extended period (Scotland, 2012).

The interpretive researcher uses a broad research question to elicit the depth of an embedded subjective world of the participant (Ritchie et al., 2013). Through elaborate interaction the researcher elicits rich constructs from the participants words that thoroughly describe and uncovers the in-depth of an ongoing event (Guba & Lincoln, 1994, p. 111; Scotland, 2012). The interpretivist researcher attempts to understand phenomena through the subjective description and meaning that people assign to them (Ritchie et al., 2013). Subjective “description and understanding” is distinguished from the “explanation and prediction” goals associated with the positivist research (Nissen, 1985; Ritchie et al., 2013).

Interpretive theory is usually grounded in data, and inductively constructed by observing patterns in the data collected from real live events (Cohen et al., 2013; Scotland, 2012). The varying constructions of the participants are interpreted using hermeneutics (extraction of deep meanings from language), and the results are compared and contrasted through dialogue to derive a consensus construction which has less personal influence or bias from both the researcher and the participants (Guba & Lincoln, 1994). Interpretivism acknowledges that it is not possible to derive a value neutral knowledge considering the choices the researcher has to make during investigation and the interaction with participants, and coupled with the researcher’s involvement in the interpretation and analysis of collected data (Edge & Richards, 1998, p. 336; Scotland, 2012).

### **3.4. Suitable Paradigm for this MHealth Research**

This section describes the paradigm choice for this study. It focuses on the role of research objective and research questions in the research design (section 3.5.1). It continues in section 3.5.2 to identify a suitable ontology for this study by comparison of other ontological position in MHealth. Section 3.5.3 distinguishes the research paradigm for this study, the soft-constructivist from the hard-positivist paradigm. Section 3.5.4 presents the paradigm alignment with research objective and questions, which points to constructivism in section 3.5.5 as the paradigm choice for this research.

### **3.4.1. Research design: using the research objective and research questions**

Research is described as a systematic and evidence based inquiry whereby data are collected, analysed and interpreted in an effort to describe, explain, or predict, as well as to design or control a phenomenon about which the researcher has interest (Gregor, 2006; O'leary, 2004; Williams, 2007). The systematic nature of research process provides researchers with the framework for defining the research objective, collecting and managing data, and communicating the findings in accordance with established research guidelines (Williams, 2007).

Research literature highlights that research objective, and the research questions are starting points which provide important hints on the substance of the phenomenon to be investigated (Saunders et al., 2009; Wahyuni, 2012). The nature of an investigator's research question dictates the type of study approach and design that might be applied to achieve the research objective. It is strongly advised that the research approach and design derive from the research objective and research questions (Saunders et al., 2009; Wahyuni, 2012). Therefore, the research questions lead to the research approach and methods to be applied. The research design articulates in advance what evidence or data is required, what method of data collection and analysis that align to properly address the research objective and answer the research questions (O'leary, 2004; Wahyuni, 2012).

### **3.4.2. Starting with research questions for MHealth inequalities**

The research objective is to explore the antecedents of inequalities in consumer MHealth innovation for the people of African background (PAB) in the Republic of Ireland (ROI), and to develop IS framework to mitigate inequalities in consumer MHealth innovation.

#### **3.4.2.1. Restating the research question 1, 2, and 3**

Three research questions are germane to address the research objective:

- **Research Question 1:** What are the antecedents of inequalities in consumer MHealth innovation for the people of African background (PAB) in the Republic of Ireland (ROI)?
- **Research Question 2:** What are the relationships between the antecedent factors and inequalities in consumer MHealth innovation for people of African background (PAB)?
- **Research Question 3:** What IS framework can we develop to mitigate inequalities in consumer MHealth innovation for people of African background (PAB)?

### 3.4.2.2. Suitable Ontology from building blocks of MHealth

The determination of the ontology in IS research derives from the building blocks of the MHealth phenomenon. Thus, MHealth is a type of health information systems (Walls, Widmeyer, & El Sawy, 1992). Information systems (IS) is defined as an “arrangement of people, data, and information technology that interact to capture, process, store, and communicate” to provide information needed to support a business organisation (Iivari et al., 1998; Nolan & Wetherbe, 1980; Orlikowski & Baroudi, 1991).

The construction of the research questions focus on information targeting- the “antecedents constructs” or factors and their relationships to MHealth inequalities (Krohn, 2020; Morley & Floridi, 2019). The context encompass the activities of the stakeholders across the MHealth ecosystem (Serbanati et al., 2011). The MHealth stakeholders’ interests and activities encompass the interaction of factors, such as the people, processes, data, information technology, information, as well as organisations involved in the activities (Iyawa, Herselman, & Botha, 2016; Morley & Floridi, 2019; Serbanati et al., 2011). These factors compose the building blocks involved in the MHealth inequalities (Iyawa et al., 2016; Morley & Floridi, 2019; Serbanati et al., 2011).

The ontology of a phenomenon is concerned with the structure and properties of “what is assumed to exist” (Iivari et al., 1998). Therefore, the ontology comprises the “basic building blocks” that make up the MHealth phenomena to be investigated. Based on the IS definition, the building blocks of the MHealth inequalities include, the people, IT, IT networks, organizations, data, information, and processes (Krohn, 2020). The ontology of the MHealth is concerned with the MHealth elements or building blocks as posited by Iivari et al. (1998, p. 172). Table 3.2 is the comparison of suggested ontology position in MHealth research.

**Table 3.2 Ontology positions in MHealth IS research**

Summary of ontological position in MHealth/IS research. This Table is adopted from (Iivari et al., 1998), and adapted for this study.			
MHealth/IS component	Realist Interpretation	Interpretivists’ Interpretation	References
people as individuals, or groups	deterministic system	Individuals who voluntarily interpret IS events based on their own context	(Iivari et al., 1998; Burrell & Morgan, 1979; McGregor, 1960; Hedberg & Mumford, 1975; Bostrom & Heinen, 1977; Dagwell & Weber, 1983)

<b>information technology</b>	technology as a causal agent	malleable structures: based on social and human choice	(Iivari et al., 1998; Ellul, 1965, p. 60); Orlikowski, 1992)
<b>organisation &amp; society, culture, influences</b>	Stable structures	interaction systems or socially constructed systems (nominalism)	(Iivari et al., 1998; Burrell & Morgan, 1979; Kling & Scacchi, 1982; Nolan & Wetherbe, 1980).
<b>information Systems networks</b>	Technical system	sociotechnical systems realizing human intentions	(Iivari et al., 1998; Goldkuhl & Lyytinen, 198; Orlikowski, 1992; Giddens 1984; Orlikowski & Robey 1991; Walsham; 1993; Iacono & Kling, 1988)
<b>data, information</b>	descriptive facts	socially constructed meanings	(Iivari et al., 1998; Klein & Hirschheim, 1987; Hirschheim et al., 1995)

### 3.4.3. Positivism versus interpretivism in MHealth

The IS research literature reveals two competing paradigms of choice, described here as “hard” positivist and “soft” interpretivist research paradigms (Chen & Hirschheim, 2004; Fitzgerald & Howcroft, 1998; Jones, 2004; Probert, 2001). Despite the traditional predominance of the positivist approach, the hard versus soft debate has played an important role of promoting the complementary strengths on both sides of the argument (Fitzgerald & Howcroft, 1998; Probert, 2001). Fundamental research philosophies have traditionally focused on the dichotomous characteristics, however a more contemporary viewpoint embraces either or both approaches based on relevance instead of contrasting them as polar opposites. The paradigm contrast provides a useful opportunity for understanding how scientific research within IS field is conducted and how knowledge claims gain credibility rather than conflicting goals. A comparison is made between interpretivism and positivism for a suitable choice in exploratory research. Interpretivism is adopted for sociotechnical research and concerned with theory building and individual-centred perspective which uses naturalistic contexts and qualitative methods. The comparison between positivism and interpretivism (Table 3.3) is the springboard upon which interpretivism is adopted as the suitable choice for addressing the objective of this research. Table 3.3 Summarises the dichotomies between hard-positivist and soft-interpretivist in IS research, as identified in Fitzgerald and Howcroft (1998).

**Table 3.3 Paradigm Comparison: Hard-Positivists versus Soft-Interpretivist Paradigm**

<p>Dichotomies between positivist and interpretivist in IS research. This Table is adopted from (Fitzgerald &amp; Howcroft, 1998; Khazanchi &amp; Munkvold, 2003) and adapted for this study</p>	
<p><b>PARADIGM LEVEL</b></p>	
<p><b>Interpretivist</b> No universal truth. Understand and interpret from researcher’s own frame of reference. Uncommitted neutrality is impossible. Realism of context important.</p>	<p><b>Positivist</b> Belief that world conforms to fixed laws of causation. Complexity can be tackled by reductionism. Emphasis on objectivity, measurement, and repeatability</p>
<p><b>ONTOLOGICAL LEVEL</b></p>	
<p><b>Relativist</b> Belief that multiple realities exist as subjective constructions of the mind. Socially transmitted terms direct how reality is perceived, and this will vary across different languages and cultures.</p>	<p><b>Realist</b> Belief that external world consists of pre-existing hard, tangible structures which exist independently of an individual’s cognition.</p>
<p><b>EPISTEMOLOGICAL LEVEL</b></p>	
<p><b>Subjectivist</b> Distinction between the researcher and research situation is collapsed. Research findings emerge from the interaction between researcher and research situation, and the values and beliefs of the researcher are central mediators.</p>	<p><b>Objectivist</b> Both possible and essential that the researcher remain detached from the research situation. Neutral observation of reality must take place in the absence of any contaminating values or biases on the part of the researcher.</p>
<p><b>Emic/Insider/Subjective</b> Origins in anthropology. Research orientation centred on native/ insider’s view, with the latter viewed as the best judge of adequacy of research.</p>	<p><b>Etic/Outsider/Objective</b> Origins in anthropology. Research orientation of outside researcher who is seen as objective and the appropriate analyst of research.</p>
<p><b>METHODOLOGICAL LEVEL</b></p>	
<p><b>Qualitative</b> Determining what things exist rather than (numbers) how many there are. Thick description. Less structured and more responsive to needs and nature of research situation.</p>	<p><b>Quantitative</b> Use of mathematical and statistical (numerical) techniques to identify facts and causal relationships. Samples can be larger and more representative. Results can be generalized to larger populations within known limits of error</p>
<p><b>Exploratory</b> Concerned with discovering patterns in research data, and to explain/understand them. Lays basic descriptive foundation. May lead to generation of hypotheses (Ponelis, 2015)</p>	<p><b>Confirmatory</b> Concerned with hypothesis testing and theory verification. Tends to follow positivist, quantitative modes of research.</p>
<p><b>Induction</b> Begins with specific instances which are used to arrive at overall generalizations which can be expected on the balance of probability. New evidence may cause conclusions to be revised. Criticized by many philosophers of science but plays an important role in theory/hypothesis conception.</p>	<p><b>Deduction</b> Uses general results to ascribe properties to specific instances. An argument is valid if it is impossible for the conclusions to be false if the premises are true. Associated with theory verification/falsification and hypothesis testing</p>
<p><b>Field</b></p>	<p><b>Laboratory</b></p>

Emphasis on realism of context in natural situation, but precision in control of variables and behaviour measurement cannot be achieved.	Precise measurement and control of variables, but at expense of naturalness of situation since real-world intensity and variation may not be achievable.
<b>Idiographic</b> Individual-centred perspective which uses naturalistic contexts and qualitative methods to recognize unique experience of the subject.	<b>Nomothetic</b> Group-centric perspective using controlled environments and quantitative methods to establish general laws.
<b>AXIOLOGICAL LEVEL</b>	
<b>Relevance</b> External validity of actual research question and its relevance to practice vital, rather than constraining the focus to that researchable by “rigorous” methods.	<b>Rigor</b> Research characterized by hypothetico-deductive testing according to the positivist paradigm, with emphasis on internal validity through tight experimental control and quantitative techniques.

#### 3.4.3.1. Suitable ontology for MHealth

Information System building blocks comprise of people, data, information technology, organisations and processes that interact with each other (Iivari et al., 1998; Orlikowski & Baroudi, 1991; Orlikowski & Robey, 1991). Similarly, MHealth inequalities are sociotechnical phenomenon which involve people, technology, process and context (Orlikowski & Baroudi, 1991). A reasoned and reflective adoption of the paradigms suggest a position which captures both the social and technical interaction between information technology, people and organisations (Orlikowski & Baroudi, 1991; Orlikowski & Robey, 1991).

#### 3.4.3.2. Consumer MHealth activities are natural and contemporary

Essentially, the objective of this study is to document in detail the conduct of everyday events associated with the consumer MHealth. The consumer MHealth is operationalized in this research with MHealth activities for physical exercise and fitness (PAF). Therefore, the research involves the use of MHealth for physical activities and fitness for PAB individuals in the ROI.

The data collection is required to capture the meaning which has been assigned to the events of the MHealth PAF, by the PAB individuals and the researcher who witnesses them (Erickson, 2012). The research is focused on discovering patterns of a contemporary sociotechnical phenomenon which shapes the perceptions of PAB individuals. Therefore the study aims to capture MHealth PAF events and their meaning from the witnesses by gathering rich content of the event-narratives (qualitative) of social actions and their meanings (perspectives), rather than quantitative measurement (Erickson, 2012; Ritchie et al., 2013). The overriding focus is

on the significance of the events that shape the perception of the PAB individuals of their MHealth experiences.

#### **3.4.4. Paradigm alignments with research objective and questions**

The positivist and interpretivist paradigm have been outlined previously to highlight their relevance especially in IS context (Burrell & Morgan, 1979; Guba & Lincoln, 1994; Iivari et al., 1998; Kuhn, 1970). The research objective and research questions are the central focus around which the important paradigm decisions rely (Erickson, 2012). The prerequisite for a rigorous paradigm choice is to ensure “alignment between the belief system” underpinning the research objective, the research questions, and the research approach (Teherani, Martimianakis, Stenfors-Hayes, Wadhwa, & Varpio, 2015).

#### **3.4.5. Interpretivism for MHealth research**

The interpretivists’ position represents the researcher’s own philosophical assumptions for this research. The suitability of the interpretivist position underpinning this research is further confirmed in the information provided. Recent efforts and commitment of the IS community have resulted to major achievements and the acceptance of Interpretivism among the mainstream paradigms of the IS research community (Klein & Myers, 2001; Markus & Lee, 1999). The foundational underpinnings of the interpretivist’s paradigm choice are further highlighted in the sections below.

##### **3.4.5.1. Relativism: the Ontology choice in MHealth research.**

This researcher believes that the IS events are socially constructed realities of individuals who voluntarily interpret the experiences of their world (Iivari et al., 1998, p. 110). The experiences and understanding of the IS events are based on the individual and social constructs of the people (Fitzgerald & Howcroft, 1998; Scotland, 2012). The researcher believes that there is no universal truth in this case, and disagrees with the positivists stance that the world always conforms to fixed laws of causation (Fitzgerald & Howcroft, 1998; Guba & Lincoln, 1994). The researcher’s emphasis is focused on the contextual experience of everyday events, not based on positivist’s objectivity, nor quantitative measures (Fitzgerald & Howcroft, 1998; Klein & Myers, 2001). Therefore the researcher does not believe that there is “one verifiable reality” underpinning the IS events, as proposed by positivists (Guba & Lincoln, 1994). Again, human perceptions and intentions are subjective, not observable or measurable facts as proposed by the positivists’ (Bogdan & Biklen, 1998; Golafshani, 2003).

#### 3.4.5.2. Ontological choice of relativism for MHealth research questions

IS literature posits that the positivists' scientific methods developed for understanding the natural world are often unsuitable for the social world (Orlikowski & Baroudi, 1991; Scotland, 2012). Positivists seek to reduce and control complexities, which is not possible with social (cognitive and behavioural) human interaction variables (Scotland, 2012). Studies show that it is problematic to effectively embrace the positivist notion (objective reality and social facts), and still capture human behavioural variables which are not always obvious (Golafshani, 2003; Orlikowski & Baroudi, 1991). For example, positivism in its scientific generalisations often neglect the complex and hidden human intentions which is better understood from individuals' perspective (Scotland, 2012). Literature reveals that, IS scholars have recently allowed multiple or alternative methods of investigation to improve research outcome (Orlikowski & Baroudi, 1991; Orlikowski & Robey, 1991; Wildemuth, 1993; Wynn Jr & Williams, 2012).

#### 3.4.5.3. Epistemological choice of subjectivism for MHealth inequalities

Subjectivism is the researchers position underpinning what counts as knowledge in IS, and "how that knowledge is acquired" (Guba & Lincoln, 1994). Subjectivism is transactional and the researcher and the object of investigation are interactive during the contemporary investigation (Guba & Lincoln, 1994). Subjectivism in IS events is the epistemology and the claim that the IS phenomena is not independent of our human knowledge (Iivari et al., 1998; Scotland, 2012). Subjectivism understands social world of information systems from the point of view of individuals who are participating in the contemporary IS events (Cohen et al., 2013; Iivari et al., 1998). Therefore, interpretivist researchers delve into direct interaction to investigate events and behaviours that capture and reveal hidden social forces and structures that would not have been otherwise obvious (Klein & Myers, 2001; Scotland, 2012). During the investigation process, the researcher is linked to the phenomenon of investigation, and sometimes may inadvertently influence, but not alter the research finding (Guba & Lincoln, 1994).

#### 3.4.5.4. Methodology for MHealth study: qualitative, exploratory and inductive

The methodological option describes how the researcher would go about to investigate what can be known (Guba & Lincoln, 1994). The methodology of the interpretivist paradigm is "hermeneutical and dialectical" in which individual constructions can be elicited by the researcher through interactions with the participant (Scotland, 2012).

With regard to the research questions, gathering evidence from participants about the “antecedents of inequalities in consumer MHealth requires interaction where the researcher collects data by observing the live events and asking question (Erickson, 2012). The researcher creates the required evidence by immersion and interaction through constructive language, shared meaning, documents, tools, and related artefacts to uncover layers of understanding (Klein & Myers, 2001; Scotland, 2012). This method of acquiring knowledge can aligns with the paradigm choices of the study, and adequately address the research questions (Fitzgerald & Howcroft, 1998).

3.4.5.5. Exploratory: contemporary events in natural settings which cannot be manipulated

The research questions in this study are exploratory in nature and derive from events of natural settings which cannot be manipulated. Moreover, the research has taken an exploratory approach to address the paucity of relevant literature in MHealth inequalities, and to provide a rich understanding of the phenomenon (Fitzgerald & Howcroft, 1998; Ponelis, 2015). The naturalistic study also provides opportunity to generate propositions that improve the limited and undeveloped body of knowledge of MHealth inequalities. It is not possible to manipulate the events of MHealth inequalities or its subjects; it is contemporary in nature which lends itself to exploratory research (Jaeger & Halliday, 1998; Ponelis, 2015). The researcher entered the field of study without a preconception or expectations about the study (Goulding, 1999; Moghaddam, 2006). Consequently, qualitative data analysis and its inductive approach is most suitable for discovery of information from data evidence and proceeding to a broader generalization of theory (Fitzgerald & Howcroft, 1998; Gioia, Corley, & Hamilton, 2013). The research design is targeting, observation, patterns, propositions, for theory (Figure 3.1).

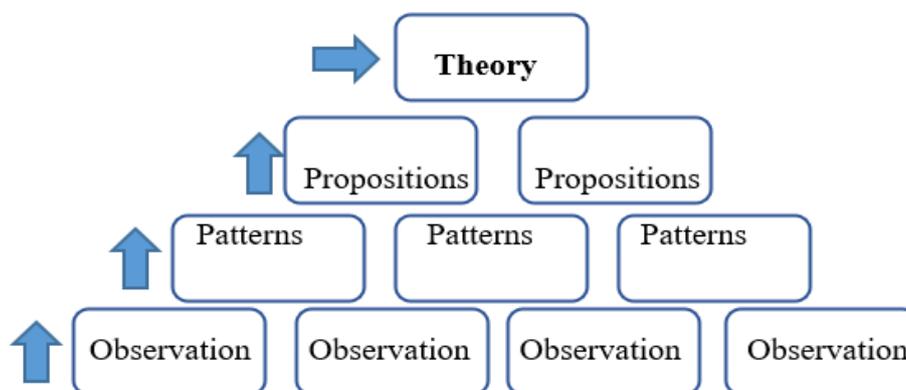


Figure 3.1 Research design: theory building- observation, patterns, propositions, to theory

### **3.5. Research Strategy**

This section describes the methodological choice in terms of quantitative, qualitative, or a mix method, which are the three common approaches to social scientific investigation. The section starts with the overview of research designs in terms of quantitative, qualitative or mix method in section 3.6.1, It proceeds in section 3.6.2 with the justification for qualitative research design. Section 3.6.4 underscores the requirement for robustness in naturalistic inquiry, and section 3.6.5 presents a choice of case study research method for this research.

#### **3.5.1. Research design: data collection, analysis, and presentation**

##### **3.5.1.1. Quantitative, qualitative, and mixed method research**

The three common approaches to social scientific investigation involve the use of either quantitative data, qualitative data, or a mix method (O'leary, 2004). Quantitative research method involves “facts and causal relationships, with numerical data” and the use of mathematical and statistical techniques (Fitzgerald & Howcroft, 1998; Khazanchi & Munkvold, 2003). Alternatively, qualitative methodology focuses on qualitative data, to discover what things exist (rather than numbers, or how many there are) (Fitzgerald & Howcroft, 1998; Khazanchi & Munkvold, 2003). Third option is the “mixed method” which combines both quantitative and qualitative data collection, interpretation, analysis and presentation (McDougall, Rajabifard, & Williamson, 2007).

##### **3.5.1.2. Quantitative Method**

Quantitative research is based on numbers, counts and the use of mathematical and statistical analysis, and interpretation for deductive (uncovering) reasoning to generate meaningful understanding (O'leary, 2004; Teddlie & Tashakkori, 2009). The strengths of quantitative research derive from its clear criteria and established mathematical and statistical technique for identifying relationships among constructs, with reliable results which can be generalised to larger populations (Fitzgerald & Howcroft, 1998; Venkatesh, Brown, & Bala, 2013). Samples can be larger and more representative in quantitative research. Quantitative results can be generalized to larger populations within known limits of error.

##### **3.5.1.3. Qualitative Method**

Unlike quantitative research which is based on numbers, counts and measures of the variables, qualitative studies are concerned with rich and quality data such as words, expressions, pictures, descriptions and narratives (Hair, Black, Babin, Anderson, & Tatham, 2006; Ritchie

et al., 2013). Qualitative research involves a wide range of approaches and data collection using interviews, documents and participant observation (Denzin & Lincoln, 2011; Ritchie et al., 2013). Qualitative findings derive from thematic analysis and interpretation for inductive (discovering), conceived from specifics in the observations of data and emerging to a broader generalization of theory (Gioia et al., 2013; Myers & Avison, 1997; Ritchie et al., 2013). Qualitative research is directed at providing in-depth account and rich interpreted understanding of the contemporary social world of research participants (O'leary, 2004; Ritchie et al., 2013). The researcher directly learns of the participant's construction and the sense they make of real-life circumstances and experiences (Myers & Avison, 1997; Ritchie et al., 2013).

General examples of qualitative research strategies include action research, ethnographic studies, and case studies (Marshall & Rossman, 2014; O'leary, 2004; Scotland, 2012). For example, most action research are designed to target knowledge and technical action for change; ethnographic studies are used to target cultural groups over a prolonged period, while case studies are used to pursue in-depth accounts of contemporary real-life events or processes over a prolonged period (Marshall & Rossman, 2014; O'leary, 2004; Scotland, 2012).

Qualitative researchers have a broad choice for their research design based on a mix of factors. Qualitative mix include the research objective and questions to be addressed, the methodological assumptions, the context and characteristics of the research participants, as well as the stance of both the research audience and the researchers (O'leary, 2004; Ritchie et al., 2013). Despite its inherent diversity, qualitative research is described as mainly interpretive approach, concerned with exploration in a naturalistic environment focusing on the accounts of the research participants as starting point (Denzin & Lincoln, 2011; Ritchie et al., 2013).

#### 3.5.1.4. Limitations of Quantitative and Qualitative

Both quantitative and qualitative approaches have inherent limitations (Myers & Avison, 1997; Salomon, 1991). Quantitative approaches are the kind of research suited for scientific experiments involving causal relations among distinctive variables, and leading to theory testing (Creswell & Creswell, 2017; Salomon, 1991). While qualitative research is suitable for contemporary “complex learning environment undergoing change” and leading to theory building (Creswell & Creswell, 2017; Salomon, 1991). Quantitative approach is analytic while qualitative approach is systematic and differing in their paradigmatic assumptions (Ritchie et al., 2013; Salomon, 1991). Qualitative or quantitative divide have been described as referring to types of data and modes of analysis (Creswell & Creswell, 2017; O'leary, 2004). As such

qualitative data are represented by words, pictures, or descriptions and analysed by using thematic exploration, while quantitative data are represented by numbers which are analysed by using statistical mathematics (O'leary, 2004).

#### 3.5.1.5. Mixed Method

The weaknesses of a single approach are minimised through the complementary approach of using a mixed method (Creswell & Clark, 2017; McDougall et al., 2007). The mixed method combines the approach for collecting and analysing data by integrating the best of both quantitative and qualitative data at various stages of the research process (Creswell & Clark, 2017). Mixed method uses quantitative and qualitative data within a single study for the purpose of gaining a better understanding of the research problem (Creswell & Clark, 2017; Teddlie & Tashakkori, 2009). The use of a mix method transcends the quantitative/qualitative divide and minimises the weakness of a single approach by integrating quantitative and qualitative data in either parallel or sequential phase of the research (McDougall et al., 2007; Salomon, 1991). The mix method uses quantitative data for deductive (uncovering) and qualitative data for inductive reasoning (discovering patterns) to generate meaningful understanding (O'leary, 2004).

### **3.5.2. Justification for qualitative research approach**

#### 3.5.2.1. Qualitative approach to correspond with research objective for exploration, description, and explanation

Research designs involve weighing several pros and cons to determine what type of data and the corresponding mode of analysis suitable to answer the research questions (O'leary, 2004). There are common factors to be considered as part of the requirement to identify the suitability of an interpretivist qualitative research. The aim of using interpretive method in IS research is to create an understanding of the contemporary experience and/or the natural context in which the information system occurs (Klein & Myers, 2001; Walsham, 2015).

#### 3.5.2.2. Research questions targeting contemporary events of sociotechnical environment

Research questions targeting contemporary events of sociotechnical environment such as MHealth often lend themselves to qualitative study approaches. The social researcher might simply wish to create a rich description of contemporary events, or the participants experience in the natural contexts in which the event occurs. This basic conception of the entire situation of the phenomenon is critically important in developing a standardized protocol, which can

also be replicable by others who want to repeat the research process. Bearing in mind that qualitative methods are ideally suited for answering exploratory and descriptive questions (Ponelis, 2015).

Again, the research objective is to explore the antecedents of inequalities in consumer MHealth innovation for the people of African background (PAB) in the Republic of Ireland (ROI), and to develop IS framework to mitigate inequalities in consumer MHealth innovation (section 3.2). To achieve this objective an interpretivist stance is adopted. Adopting the interpretivist assumption means that our knowledge of reality is gained only through social constructions which derive from rich and quality data such as words of language, pictures, descriptions and narratives directly from the research participants to the researcher (Ritchie et al., 2013).

#### 3.5.2.3. Captures the complexity of real life, and human sense making in natural settings

The interpretivist paradigm is best suited to capture the complexity of human sense making in natural settings by using data in the form of words rather than numbers to capture the situation as it emerges (Ritchie et al., 2013). The study of inequalities in MHealth innovation represents a real-life and contemporary social event, in a natural setting where factors interdependently interact and emerge in ways that can be captured in their patterns (Klein & Myers, 2001).

#### 3.5.2.4. Providing in-depth account of social world suitable for theory building

This researcher has taken a constructivist stance and adopted a qualitative approach for theory building (Creswell & Creswell, 2017; Gregor, 2006). Qualitative research aims to provide in-depth account and rich interpreted understanding of the contemporary social world of research participants and the complexities of their real life setting (O'leary, 2004; Ritchie et al., 2013). The researcher directly learns from the participant's construction and the sense they make of their real-life circumstances and experiences as they emerge (Myers & Avison, 1997; Ritchie et al., 2013).

#### 3.5.2.5. Flexible data collection adaptable to explore social context of each participant

A qualitative approach enables flexible data collection method that can be adaptable to capture the social context of each case of the participants, to allow the exploration of the phenomenon in a natural setting (O'leary, 2004). Qualitative method of data collection is suited to capture rich data in a complex learning environment of change (O'leary, 2004; Salomon, 1991).

### 3.5.2.6. Capitalises on authenticity of the detailed descriptions of the research events

Qualitative data analysis is able to retain both the unique and shared features of the participants and emergent issues evolving in the analysis up to the interpretation stage (O'leary, 2004). The systematic approach of the qualitative process capitalises on authenticity of the detailed descriptions of the research events grounded in the perspectives of the research participant and also reflective of the researchers active involvement throughout the research process (O'leary, 2004; Salomon, 1991). The transactional manner of the qualitative process captures changes and the emergent patterns that summarise the research study (Salomon, 1991). Table 3.4 contains the essential attributes or common characteristics of qualitative research approach.

**Table 3.4 Common characteristics of qualitative research approach**

Characteristics of qualitative research: Table 3.4 is adopted from Ritchie et al., 2013, and adapted for this study		
<b>Aims and objectives</b>	Exploring in-depth accounts of the participant's construction and their social world, material circumstances, experiences, and perspectives.	(Flick, 2009; Ritchie et al., 2013)
<b>Data generation</b>	Exploring social context and adaptable for each individual case and emergent issues	(Denzin & Lincoln, 2011)
<b>Data</b>	Rich , detailed, and complex data; , usually involving words and images instead of numbers	(Denzin & Lincoln, 2011; O'leary, 2004)
<b>Analysis</b>	Analysis requires to retain complexity, and respect both individual participants characteristics and common themes	(Klein & Myers, 2001)
<b>Interpretation</b>	Open to emergent categories and theoretical constructs	(Creswell & Creswell, 2017)
<b>Findings</b>	Outcome to include detailed descriptions of the research phenomena, grounded in the construction of participants	(Ritchie et al., 2013)
<b>Report</b>	Reflexive report that is cognisant of researcher role in the research process and field experience	(Fitzgerald & Howcroft, 1998; Ritchie et al., 2013)

### **3.5.3. Robustness of naturalistic research methodology**

#### **3.5.3.1. Robustness of Naturalistic Research is a methodological concern**

Methodological concerns is a source of debate in naturalistic studies that often involve gathering non-random samples to generate complex qualitative data, and targeting holistic meaning (O'leary, 2004; Ritchie et al., 2013). Also complexities in qualitative research data analysis arise from inherent constructive biases and negotiated interpretations between participants and researchers (Edge & Richards, 1998; O'leary, 2004). Moreover, the emergent nature of qualitative methodological criteria, including inductive analysis and idiographic interpretations give rise to credibility concerns for the research findings (Edge & Richards, 1998; O'leary, 2004).

#### **3.5.3.2. Reliability and validity in naturalistic research**

There are ongoing debates about using similar measures of credibility applicable in quantitative studies, in terms of objectivity, reliability, generalisability and other rigorous measures (Guba & Lincoln, 1994; Tobin & Begley, 2004). However, some qualitative researchers emphasise that the quality of a grounded theory should not be evaluated according to standard positivists' criteria of theory testing, i.e. objectivity, reliability and validity, but by using different criteria such as credibility, plausibility, and trustworthiness (Kaiser & Presmeg, 2019). The recommendation for measures of reliability and validity is that, regardless of paradigmatic positioning, research studies, especially those which rely on qualitative data, should address methodological concerns that may bias subjective interpretations or negatively impact broad applicability and verifiability of research finding (Guba & Lincoln, 1994; O'leary, 2004).

Assessment of trustworthiness in qualitative study uses equivalent measures for objectivity, reliability, and validity. Although suggestions vary among qualitative researchers, most authors emphasise the need to embrace methodological criteria that ensure robustness of naturalistic research assessment and findings (Edge & Richards, 1998; Guba & Lincoln, 1994). Assessment of trustworthiness is said to serve as the equivalent measures of "objectivity, reliability, and validity" obtainable in the positivist stance (Edge & Richards, 1998; O'leary, 2004). Lincoln and Guba translated these underlying quantitative concepts to reflect their equivalence in naturalistic inquiry (Edge & Richards, 1998).

### 3.5.3.3. Nuances of translating quantitative measurement criteria across paradigms

Some qualitative researchers accept and advocate for equivalent measures of credibility and reliability (de Vaus, 2001; Golafshani, 2003; O'leary, 2004; Thomson, 2011). Some other qualitative researchers debate the adequacy of translating quantitative measurement criteria across paradigms (Adcock & Collier, 2001; Edge & Richards, 1998). For instance, O'leary (2004) opines that the credibility of qualitative assessment criteria should ensure “neutrality or transparency of subjective constructions, to serve in place of objectivity”. The author posits that dependability should replace reliability; authenticity to replace validity, transferability to replace generalizability, and auditability in place of reproducibility (O'leary, 2004). The general suggestion is that qualitative studies that attempt to delve deeper can establish research credibility through other means by using “strategies that ensure thoroughness” (Cope, 2014; Decrop, 2004; Elo et al., 2014; Houghton, Casey, Shaw, & Murphy, 2013; Lincoln & Guba, 1985; O'leary, 2004; Thomson, 2011).

A notion among qualitative researchers suggest that an outright rejection based on traditional emphasis on quantitative criteria of research rigour undermines the credibility of qualitative research process and its ability to contribute to the advancement of knowledge (Adcock & Collier, 2001; Denzin & Lincoln, 2011; Tobin & Begley, 2004). Some social scientists argue that the use of equivalent measures across paradigms should be deemed inappropriate and disregarded. However, most social researchers still believe that connecting phenomenon to facts raise basic questions of credibility such that observations should meaningfully reflect the right phenomenon (Adcock & Collier, 2001; de Vaus, 2001).

### 3.5.3.4. Robustness in qualitative research: equivalence of reliability and validity

Demonstrating robustness in qualitative research can be achieved through the equivalence of reliability, internal and external validity which applies in quantitative research. Reliability ensures consistency of measurement instruments. For demonstrating robustness, reliability is generally used to ensure that indicators or measurement instruments are consistent when used on repeated occasions (de Vaus, 2001; Edge & Richards, 1998; Golafshani, 2003). Measurement of reliability ensures that repeated operations of the study under similar circumstances can repeatedly lead to the same result (Yin, 1984 p. 36).

Qualitative equivalence of internal validity ensures that the structure of a research design delivers the target conclusion it is designed for, enabling the researchers to draw unambiguous conclusions from their results; and helping researchers to eliminate possible alternative

explanations that may invalidate their findings (de Vaus, 2001; Gregor, 2006, p. 625; O'leary, 2004). Similarly, the qualitative equivalent of external validity ensures that the result of a study can be generalised beyond the particular study, as such, the findings do not restrictively apply only to those people in that particular investigation (de Vaus, 2001; O'leary, 2004).

Data triangulation is also used to achieve robustness in naturalistic inquiry. In addition to triangulation of research evidence, other methods of achieving robustness in naturalistic studies are enshrined in the principle of qualitative data sampling, data collection and analysis (Sandelowski, 2000; Tobin & Begley, 2004).

### **3.5.4. Research method: case study method with multiple cases**

#### **3.5.4.1. Delving deeper into complexities of social inquiry by using few cases for rich data**

The aim of a naturalistic inquiry and investigation into the social world often requires the researcher to delve deeper by focusing on few cases of participants, to generate rich, detailed, and complex data (O'leary, 2004; Ritchie et al., 2013). “Delving deeper” and focusing on few cases for rich data helps researchers to gain intimate understanding of the participants by learning about the sense they make of their interactions, context, cultures, real life events, lived experiences, and circumstances, as individuals, or as part of a group or institution (Ritchie et al., 2013).

#### **3.5.4.2. Case Study bounded by time and place, no explicit control over the context**

Case study is defined by Creswell as an investigation that requires a researcher to “explore in depth a program, an event, an activity, a process, involving one or more individuals, or a case bounded by time and place (Creswell, 2003; Creswell & Poth, 2016). Case study is suitable for understanding a social phenomenon through in-depth description and analysis of a single situation or multiple cases (O'leary, 2004). Case study method enables researchers to investigate in detail, a pre-defined, real life social phenomenon in natural setting (O'leary, 2004). The case may focus on an individual, group, event, episode or other units of social life with the aim to derive comprehensive description and analysis of the case without explicit control of the context (Kaarbo & Beasley, 1999; O'leary, 2004). Case study emphasis are often placed on understanding the uniqueness as well as the common attributes of the case elements. Case studies can actually involve various data gathering methods, such as surveys, interviews, observation or documents analysis which may adopt quantitative or qualitative approach (de

Vaus, 2001; O'leary, 2004). Case study provides “authenticity and richness” of data, and reveals in-depth understanding that exceeds any information from the wider domain that is generally possible in large-scale survey research (O'leary, 2004).

Case study approach is one of the commonly used research methods in the IS field when in-depth understanding of a social phenomenon is required in its context (Benbasat, Goldstein, & Mead, 1987; Gregor, 2006; Walsham, 1995). Case study is a valuable approach when there is paucity of knowledge or the phenomenon is under-investigated, creating the need for discovery as well as theory building (Gregor, 2006). Case study evidence and conclusions derive from sources such as semi-structured interviews, direct observations, document analysis, archival files, actual artefacts, think-aloud protocols, and role-play demonstrations (Scotland, 2012).

3.5.4.3. Multiple case in population-based research allows comprehensive data, enrich the case context, and enable comparison

Although single case study can richly describe a phenomenon, however, population based research attempts to build holistic understanding and a stronger theoretical base by incorporating more sites (O'leary, 2004). Multiple case studies allow for “initial grounded exploration” of cases through interactive discussions which provide valuable opportunities for “silenced-voices” and “suppressed-expressions” (Dickson-Swift, James, Kippen, & Liamputtong, 2007). Case studies give voices to suppressed experiences of low socio-economic populations, the underserved or the hard-to-reach minorities as they are pejoratively described (Dickson-Swift et al., 2007; Dickson-Swift, James, Kippen, & Liamputtong, 2009).

3.5.4.4. Suitability of cases to illuminate and extend relationships and logic among constructs

A multiple case study was considered suitable for this study. Multiple case study enables a comprehensive data gathering to expand the richness of the case and context, and to support comparison for comprehensive understanding of the phenomenon (O'leary, 2004; Wahyuni, 2012). Particularly, cases are selected because they are “suitable for illuminating and extending relationships and logic among constructs” (Eisenhardt & Graebner, 2007). Theory from multiple cases are better grounded in varied empirical evidence, they are more accurate, and more generalizable (Eisenhardt & Graebner, 2007).

### 3.5.4.5. Inequalities in consumer MHealth for physical activity and fitness (PAF)

The case in this inquiry involves the antecedents of inequalities in consumer MHealth for physical Activity and fitness for the people of African background (PAB) in the Republic of Ireland (ROI). The PAB participants are women and men, aged 18 – 64, in the ROI who are engaged in active living (Health & Children, 2009, p. 13; Organization, 2015, 2019). This study has chosen multiple case study to enable comprehensive data gathering to support comparison of comprehensive data. Comprehensive data during collection, interpretation, analysis, and presentation, expands the richness of the case and context for understanding inequalities in consumer MHealth. There are case study characteristics that correspond to the requirements of this study. More information on the suitability of case study for this research is provided in Table 3.5. The table depicts the requirements of this study and the corresponding case study characteristics that are suitable for the study.

**Table 3.5 Case study characteristics that correspond to the requirement of this study**

Case study characteristics that correspond to the requirement of this study		
Requirements of this Study	Case Study Characteristics	Ref
<b>Research objective</b>	Exploration of antecedents of inequalities in consumer MHealth; and to conceptualise an IS framework to mitigate the factors.	(Marshall & Rossman, 2014; O'leary, 2004)
<b>Type of Research Question</b>	Exploring what are, and how of the antecedents of inequalities in consumer MHealth; and proposing IS remedial framework	(de Vaus, 2001; DiMaggio & Hargittai, 2001)
<b>Theory Building EP Theory: how the world is &amp; how it can be</b>	Explanation & prediction (EP) theory building; begins with observation, uses inductive reasoning, derive patterns for post factum theory'. *Explanation theory sensitising knowledge of MHealth inequalities; *and prescription of equitable MHealth remedy	(de Vaus, 2001; Gregor, 2006; Merton & Merton, 1968; Whetten, 1989)
<b>Key issues in this explanation and prediction</b>	*The antecedents of inequalities in <i>MHealth innovation</i> *antecedents of MHealth inequalities * Factors derive from the accounts of the participants MHealth experiences as measured by their unfair differences or disadvantages in their MHealth activities, and transaction with environment	(de Vaus, 2001; DiMaggio & Garip, 2012; DiMaggio & Hargittai, 2001)
<b>Idiographic Investigation</b>	The evidence and conclusion build from the participants' accounts focusing attention on individual, social and environmental factors of unfair differences of MHealth disadvantage	(Iivari et al., 1998; McLeroy et al., 1988; Stokols, 1992)
<b>Case Study structure – problem, context, phenomenon, target knowledge</b>	*Phenomenon - In-depth exploration of the MHealth inequalities: *Real life contemporary of unfair differences, disadvantage in MHealth *Natural context- life experience of ethnic African minorities in the ROI *to understand patterns of antecedents of MHealth inequalities *Propose equitable IS framework	(Creswell, 2003; Creswell & Creswell, 2017; O'leary, 2004)

<b>Interpretivist Paradigm</b>	In-depth study of cases mainly relies on constructivist paradigm, which claim that truth is relative, and based on the accounts of the participant who subjectively construct their meaning based on their experiences and circumstances	(Klein & Myers, 1999)
<b>Case Study exploration</b>	Case study is required because there is paucity of knowledge and limited understanding of digital inequalities in general, and MHealth inequalities in particular	(Benbasat et al., 1987; Hsieh et al., 2008; Leedy & Ormrod, 2001; Marshall & Rossman, 2014)
<b>Grounded Theory Methodology</b>	Qualitative data analysis is a grounded theory methodology for theory development. “One characteristic of grounded theory is that data collection, data analysis, and theory development are not successive steps in the research procedure but are intertwined and interdependent. Thus, action in terms of data collection and reflexion in terms of data analysis and theory development always alternate”.	(Kaiser & Presmeg, 2019, p. 85)

### 3.6. Data Gathering Protocols for Qualitative Research Strategy

#### 3.6.1. Introduction

This section presents the data gathering protocol. In section 3.7.2 it presents information about the researcher’s documentation of the research instruments. Section 3.7.3 pretends the operationalization of MHealth, and section 3.7.4 focuses on the final preparation for the field work. Section 3.7.5 presents the data sampling strategy, and section 3.7.6 presents the recruitment process for the PAB participants in readiness for data collection.

#### 3.6.2. The documentation of the research instruments

Data collection in social research requires documentation to be approved by requisite authorities, to ensure the right standards are maintained. The documentation process for this study was duly followed by the researcher and received approval from the Social Research and Ethics Committee (SREC) of the University College Cork.

##### 3.6.2.1. Data collection protocols for multiple sources of data

Underscoring the importance of evidence, highlights the Latin phrase: “*adagio unus testis nullus testis*”; which means that one person’s evidence is insufficient evidence (Leppink, 2017, p. 285). This phrase translates to say that “the proof of evidence ought not to be anchored on a single source of information, but rather on a chain of coherent evidence without contradictions, loose ends or missing elements” (Leppink, 2017, p. 285). Therefore, this research targeted both quantitative and qualitative data through multiple sources of evidence,

which facilitated data triangulation. The data collection involved the use of the following protocols:

- **Interview Guide (Appendix B):** contains a list of topics to be covered by the interview and procedure to be followed by the researcher.
- **Information Sheet (Appendix C):** a document that explained to the participant what the research is about and what the participation would involve. This document explains that participation in the research is completely voluntary to enable each participant to make an informed choice.
  - **Consent Form (Appendix D):** a document that explained to the participant that willingness to participate in the study should be completely voluntary and based on informed choice.
  - **Demographic data questionnaire: (Appendix E)**
  - **Think-Aloud Protocol, TAP (Appendix F):** Notes of researcher's direct observation of 'incident encounters and reports recorded during participant's MHealth installation.
  - **Role-Play Demonstration, RPD (Appendix F):** Notes of researcher's direct observation reports recorded during participants' usage period of MHealth through role-play demonstration (RPD).
  - **Interview Questions (Appendix G):** individual, semi structured, in-depth, interview questions.

3.6.2.2. Ethical Approval was granted by the SREC of the University College Cork

Preparation for data collection involved ethical approval for the data collection instruments in social research. Conducting research which requires direct interaction or indirect observation with human participants for the purpose of data collection using research methods such as questionnaires, interviews, observations, focus groups etc. require approval by the Research Ethics Committee (SREC), of the University College Cork.

The researcher completed the ethics approval form required to initiate an application to the Social Research Ethics Committee (SREC), of the University College Cork, for ethics approval, for this study. This application was endorsed by the researcher's supervisors who were familiar with the ethics application details for this project. After the review process, the study received approval from the Social Research Ethics Committee (SREC), of the University College Cork. The approved data collection instruments are provided in the Appendix Section.

### **3.6.3. Operationalizing the MHealth technology in readiness for field work**

This section involves the operationalization of the MHealth technology required for the data collection from PAB participants. The MHealth operationalization contains the detail of the IT elements of the MHealth artefacts involved in this research. Inequalities in MHealth innovation is operationalised with the use of MHealth technology for physical activity and fitness (PAF) (Figure 3.2; Figure 3.3). MHealth PAF programs can reach many individuals and offer practical and cost-effective way to promote physical activity fitness (PAF) and reduce sedentary behaviour (Direito et al., 2017; Schoeppe et al., 2017).

#### **3.6.3.1. MHealth PAF is evolving and embedded in complex and dynamic social context**

The conceptualization of MHealth technology in this research represents an evolving system, embedded in a complex and dynamic social context (Avgerou, 2001; Orlikowski & Iacono, 2001). The evolving nature and the complexity as well as the dynamics of MHealth PAF pertains to PAB participants especially for their inactivity in PAF despite their potential for cardiovascular risk (BeLue et al., 2009a; Cappuccio, 1997; Crespo, Smit, Andersen, Carter-Pokras, & Ainsworth, 2000; Dagkas & Benn, 2006). This study involves the exploration of ongoing event of the case of inequalities, arising in the unfair differences or disadvantages in MHealth exemplified in PAF technology innovation.

#### **3.6.3.2. Explore MHealth PAF innovation from the perspective of PAB individuals, and how they learn about, understand, adopt, and use the MHealth artefact**

This study explored from a comprehensive perspective focusing on the periods involving three phases of consumer MHealth PAF experience, comprising of: pre-installation, installation and usage experience periods (Golafshani, 2003; Patton, 2014). The overall effort was to explore the differences in the accounts of inequalities in MHealth PAF from the perspective of individuals, and how they learn, understand, adopt, and use their artefacts in dynamic social environment (Orlikowski & Iacono, 2001, p. 129; Poirier, Staub-French, & Forgues, 2015).

Efforts were directed towards direct observational evidence to capture the overall context and situational circumstances of the PAB people and the MHealth process. Both think-aloud and role-play observational approaches were devised to capture the experiences during tasks which the participants carry out naturally as part of their habitual interaction with MHealth for PAF. The MHealth technology is a digital physical activity and fitness tracker designed to monitor, capture, store, analyse and communicate information to promote physical activity (PAF) and

reduce sedentary behaviour (Macpherson, Purcell, & Bulley, 2009; Thakkar, Jamnik, & Arden, 2018; Tudor-Locke, 2010).



Figure 3.2 MHealth PAF: an illustration with mobile fitness tracking devices

Displayed image is the property of its rightful owner; adopted (1) Fitness band, from (Bingo-Technologies, 2019); and (2) Mobile phone, from (drogatnev, 2018); images adopted from web pages and adapted for illustration.

### 3.6.3.3. MHealth for physical activity and fitness (PAF) device checklist

The case of consumer MHealth was operationalised as an innovative technology for physical activity and fitness (PAF) by using three MHealth items (Health & Children, 2009). The MHealth PAF study was designed to promote equality, inclusion and diversity in PAF participation (DiMaggio & Hargittai, 2001; DiMaggio, Hargittai, Celeste, & Shafer, 2004).

The checklist of the MHealth operationalisation involve the use of item 1. Mobile phone, and 2. Internet Connection, which were linked through item 3. Health app to item 4. Digital Activity Tracker, and item 5. Digital Weighing Scale. The researcher also carried items for administrative purposes which included the following accessories:

#### Accessories carried by the researcher

- Measuring Tape (5 Metre/16ft Measuring Tape (Powerfix-5m/16ft)
- AAA Alkaline Batteries (24 Batteries X 3 Packs)
- Digital Voice Recording Device (Samsung, Galaxy-A9, Model: SM-A9000)
- Writing materials (including Pen and paper)

### 3.6.3.4. MHealth devices in the research field were represented with the following items:

- **Participant's Mobile Phone:** A working mobile phone that belongs to the participant.

- **Participant’s Internet connection:** A working Internet connection already subscribed by the participant.
- **Sanitas-V.2.9.3, Health-coach app (Sanitas, 2020a); includes:**
  - Sanitas-V.2.9.3 health-coach app is a free health app for physical activity (PA) downloadable from online App store using participants' mobile phone
  - Health-Coach app is linked via Bluetooth to 2 devices (Digital PA tracker, and Digital weighing scale) Digital PA tracker, and device
  - Digital Physical Activity tracker with chargers - (Beurer-AS80) X 25 items

### 3.6.3.5. Digital PA tracker device- (Beurer-AS80) (beurer, 2020)

- The digital PA tracker is an activity sensor that records daily steps, duration of sleep and enables the data to be transmitted to the Smartphone via Bluetooth connection (Figure 3.3).
- Beurer-AS80 device with information manuals/unit description and quick set-up guide
- One Digital PA sensor for each PAB participant
- Digital bathroom weighing scale (Sanitas-SBF70) X 12 Items



**Figure 3.3 Activity Sensor linked by Bluetooth to Health-coach App on Mobile Phone**  
 Displayed image is the property of its rightful owner; adopted from: Sanitas HealthCoach App (Sanitas-online, 2021); adapted for illustration.

3.6.3.6. Digital bathroom weighing scale (Sanitas-SBF70) (Sanitas, 2020b) include:

- The weighing scale is a bathroom scale that reads health information and enables the data to be transmitted to the Smartphone via Bluetooth connection (Figure 3.4).
- The Sanitas-SBF70 digital bathroom scale comes with information manuals, with unit description and quick set-up guide
- One item of Digital Weighing Scale for each PAB household

Digital PA tracker - (Beurer-AS80) and the Digital bathroom weighing scale (Sanitas-SBF70) are purchased by the researcher with the support of the research institution and given to the participant to be used for the period of the study. Details of IT artefacts for MHealth Operationalization is provided in Appendix F.



Figure 3.4 Weighing Scale linked by Bluetooth to Health-coach App on Mobile phone

Displayed image is the property of its rightful owner; adopted from: Sanitas HealthCoach App (Sanitas-online, 2021); adapted for illustration.

### 3.6.4. Preparation for the field work

#### 3.6.4.1. Introduction

Field work administration preparation was made as the researcher's readiness before going into the field for data collection from the participants. This preparation involved the readiness for the collection of data from the identified sources. There were four types of preparation:

- Preparation for face-to-face socio-demographic data collection
- Preparation for think-aloud protocol (TAP)

- Preparation for role-play demonstration (RPD)
- Preparation for individual in-depth, semi-structured interview

#### 3.6.4.2. Preparation for face-to-face socio-demographic data collection

Preparation for the face-to-face socio-demographic characteristics of PAB involved the use of questionnaires for data collection from participants, before the installation of the MHealth device (pre-implementation period of MHealth).

This aspect of demographic data collection involved a total of 24 surveys conducted with PAB individuals from 12 households, between July 2019 and March 2020. The face-to-face, socio-demographic survey of participant's characteristics was also applied as part of the sampling tool. The survey targeted participant's characteristics such as individual ascriptive factors, socio-economic variables (SES), behavioural risk factors, environment, and contextual factors, as well as ownership of technology resources such as mobile phones and internet connection. The details of the face-to-face sociodemographic data collection is contained in the demographic data collection protocols. Face-to-face sociodemographic data collection was designed to target participant's characteristics. Such as: age, gender, education, employment, race and ethnic identity, ownership of technology resources such as mobile phone and internet connection. The demographic data collection activity time was about 5 - 10 minutes. Further details of face-to-face demographic data collection protocol is provided in Appendix E.

#### 3.6.4.3. Preparation for direct observation with think-aloud protocol (TAP), and role-play demonstration (RPD).

Inequalities in MHealth innovation is a new study area which requires original study insight. Extant literature shows that unless research participants are extremely insightful, they might not know or remember all the rationale for their behaviour or reasons why they do things. Extra efforts were directed towards direct observational evidence to capture the overall context and situational circumstances surrounding inequalities in MHealth for PAB community. The researcher entered the field of study without a pre-existing notion of the phenomenon and with original insight, which necessitated the use of think-aloud protocol (TAP) and role-play demonstration (RPD) as direct observational instruments for data collection. Both TAP and RPD were devised as a template for apprehending the true nature of the phenomenon, since there were no preconception or even existence of hypothesis of the area of study before entering the field of study (Goulding, 1999; Moghaddam, 2006).

The TAP and RPD was designed to capture the interactions of the participant with the MHealth tools, programmes, processes, devices, as well as the researcher. The TAP and RPD instruments add to the comprehensive data sources which ensure that the findings emerging from the evidence are valid and relevant to the participant's constructions of their lived experiences. Both TAP and RPD were devised to contextualise the task experiences which the PAB participants carry out naturally as part of their social and environmental interaction with MHealth innovation. The TAP and RPD also served as unique data collection tools, which allowed the researcher to capture the participants' immediate interaction, awareness, and reasoning without depending on delayed description from memory of previous MHealth narratives. The TAP and RPD instruments helped to distil the participant's experiences during the usage interaction with MHealth: starting – before and during MHealth installation, during MHealth usage period. Further detail of TAP and RPD data collection protocol is provided in Appendix F.

a. [Think-aloud protocol, TAP \(Appendix F\)](#)

During MHealth installation, at implementation phase, the think-aloud protocol (TAP) was used during which the participant was expected to speak-out by vocalising the activities, step-by-step, while following the installation instructions on the user manual (Lewis, 1982; Vedanthan et al., 2015). The researcher listened, observed, recorded the participant's experiences, digital skills, and incident-encounters and provided supports during the incident encounters when it was necessary (Lewis, 1982; Vedanthan et al., 2015). Similarly, after the MHealth usage period the role-play was used to capture the participant's demonstration (Vyas, Heylen, Nijholt, & Van Der Veer, 2009).

In IS research, technology artefacts can be an important evidential component in the actual observation of technology use, including the availability of digital readings, print outs or snapshots showing time, duration and dates . The use of think-aloud protocols (TAP) allow researchers to focus on the participants' immediate awareness, and reasoning without depending on the delayed explanations from the participants . The participant's accounts of their activities with the technology help them to interact with their difficulties in context which promotes greater self-understanding (Lewis, 1982).

The think-aloud protocol (TAP) in its operation is a cognitive walkthrough (Chan et al., 2002) that requires participant to “speak-out” while following the installation instructions (Charters, 2003; Vedanthan et al., 2015). The TAP protocol characterise the cognitive processes which

are performed by the participants in their interaction with MHealth technology, and encapsulate their temporal reasoning during the tasks (Martin-Rodilla & Gonzalez-Perez, 2016). Generally, TAP protocol has a strong theoretical foundation that confirms its value as a way of “exploring individuals’ thought processes” (Martin-Rodilla & Gonzalez-Perez, 2016).

The TAP is designed to capture the in-depth accounts, what participants are thinking, saying, and doing, about their experience during the installation of the MHealth technology. The researcher listens, observes, records the observation from what the participants is thinking, saying, and doing, and notes the participants skills and performance based on the incident encounters. Also the researcher provides support to the participant during “incident encounters” (Charters, 2003; Ericsson & Simon, 1980). TAP protocols have been used in different fields, including research contexts which involve the use of observation, narratives or texts (Lewis, 1982; Martin-Rodilla & Gonzalez-Perez, 2016).

Before the installation, the TAP was explained by the researcher, but not demonstrated to the participant who was required to speak-out what they were doing along the installation process while also following the installation instructions in the user manual. Details of this section of the evidence collection is contained in the TAP, provided in Appendix F.

The installation of MHealth during TAP involved the following steps:

- The MHealth devices were introduced to the PAB participants.
- The TAP was explained but not demonstrated to the participant.
- Researcher handed over each device and the installation manual in turn, to the PAB participant, for installation.
- Researcher directly observed the PAB participant and noted important steps and progress.
- During installation and setup, the researcher observed, guided or assisted the participant whenever it became necessary (Lewis, 1982; Vedanthan et al., 2015).
- After installation and health data readings from the MHealth technology, participants remained with the MHealth devices and continued to use and participate in their physical exercise and fitness using the MHealth devices, for at least eight weeks.

## b. Role-play demonstration (RPD)

The researcher returns to the PAB participant after the eight weeks of the use of MHealth technology, The RPD is a direct observation by the researcher, of the demonstration of the use of the MHealth technology. The RPD was designed to last approximately five minutes and was carried out before the in-depth interview began. Again, the RPD is the direct observation of participant's demonstration of MHealth use experience. The PAB participants' role-play with MHealth technology artefacts involved reading the MHealth data of the PAB individual, taking screenshot photo images of MHealth usage and looking at performance display. The aim of the role-play was to "illuminate human interactions, which are situated in practice" in order to discover knowledge that are mainly observed but absent from other documentation (Akama et al., 2007; Suchman, 1987; Vyas et al., 2009).

### 3.6.5. Data Sampling Strategy

#### 3.6.5.1. Data sample universe for PAB in the ROI

The study focused on people of African background (PAB) in the Republic of Ireland (ROI) (CSO, 2012; O'Connell, 2019). The people of African background or PAB living in the ROI are described by the Central Statistics Office (CSO) in the ROI and other literature as "Africans" or "people born in Africa" (CSO, 2012; O'Connell, 2019). However, PAB is a preferred acronym which the researcher decided to use in this study to represent people of African background in the ROI or people living in the ROI who were born in Africa (CSO, 2012; O'Connell, 2019).

The literature about African people in diaspora share the notion of the sensitivity surrounding their identity and the acronyms used to describe the people (Montague & Perchonok, 2012). Quite often the use of the term minority, black, black, Asian and minority ethnic (BAME) community, which do not properly identify or specifically represent some African population in diaspora. Also, these acronyms are sometimes viewed with disapproval among the people of African background (Montague & Perchonok, 2012). The researcher has chosen the PAB acronym carefully to avoid the sensitivity that surrounds identity and naming of people of African descent, especially in this case concerning a discussion about inequalities (Armaou et al., 2020; Larson, 1999; Montague & Perchonok, 2012).

The study was conducted across three Provinces of the ROI, at locations in Cork in the Munster region, Galway in Connaught, and Dublin in Leinster (Looney, 2006). A total 24 PAB

participants, male and female adults, between the ages of 18 to 54, from 12 household were recruited.

Between July 2019 and March 2020, various types of data were collected from the 24 PAB individuals by using survey questionnaires for demographic data, and field notes and reports of direct observation by using TAP and RPD, as well as audio recording of in-depth interviews. The Central Statistics Office, Census 2011 Published Report, indicated that the PAB community (people of African descent) in the ROI were 58,697 in total, which comprised of 28,847 males and 29,850 females (CSO, 2012). This number represent about 1.297% of the total population of the ROI (4,525,281 persons) in 2011 (CSO, 2012). The 1.297% ethnic African population is a minority subgroup of the Irish population. Most of the individuals of PAB are identified by the Central Statistics Office (CSO) of the ROI, in 2012, as those residing mainly within the urban towns such as Dublin, Cork, Galway, or Limerick.

#### 3.6.5.2. Sample Selection Criteria of PAB Individuals

The initial Sample criteria targeted 20 individuals within 12 households with the following characteristics

- PAB Individuals
- Resident within the ROI
- Male or female
- Adults, aged between 18 to 64 years
- Capable of at least moderate physical activity and fitness in accordance with the national guidelines for PA in the ROI (Health & Children, 2009).
- Participants are individuals who are current users of smartphones with internet access
- Individuals who have PA Apps, or willing to be introduced to PA App by the researcher
- Exclude individuals such as patients, or individuals with disability or “special needs”

#### 3.6.5.3. The Sample size: pragmatic, flexibility to saturation

This research has an idiographic objective which typically requires a sample size that is sufficiently small so that individual voices can be identified within the study and can allow in-depth analysis of each case (Robinson, 2014). It is recommended that case study sample size should be in the range of 3 to 16 participants (Robinson, 2014; Smith & Shinebourne, 2012). To represent the PAB community, this research has chosen a multiple case study of individuals, in addition the sample collection is iterative to derive a good representation of a rich sample within the PAB community.

The PAB cases are selected because they are particularly suitable to add some illumination and able to extend the relationships among the factors (Eisenhardt & Graebner, 2007). A multiple case study allows the sample size to be increased as the data collection progresses, until saturation, which can also enable corroboration while allowing distinctiveness of individual participants (Robinson, 2014). In this qualitative study there is need to monitor data collection as it progresses in order to meaningfully alter the sample size for theoretical or practical reasons (Robinson, 2014; Silverman, 2013). Therefore a flexible and organic approach is taken as a response to the practical realities that is required in this research to avoid potential challenges associated with in-depth data collection (Mason, 2017; Robinson, 2014). This flexibility allows the sample size to be increased if the ongoing data collection realises the need to add important group to the sample to enhance credibility of the research or achieve theoretical saturation (Robinson, 2014; Silverman, 2013). The sample universe in this study is taken from the population of PAB community, which comprise less than 1.3% of the ROI population of about 4.5 million people (CSO, 2012).

#### 3.6.5.4. PAB Population identified as invisible-class and hard-to-reach

The phenomenon of inequalities in MHealth innovation encompass the entire population of the PAB in the ROI (Servon, 2008; Wilson, Wallin, & Reiser, 2003). The PAB is insignificant when compared to the mainstream population in the ROI. Quite often, when they are outside the African continent, PAB individuals are an invisible-class, sometimes identified as the hard-to-reach as they are often pejoratively regarded (Fairlie, 2014; McLeroy et al., 1988)

#### 3.6.5.5. Purposive Quota Sampling strategy

Qualitative inquiry typically focuses in-depth on relatively small samples, selected purposefully from the total population under investigation (Patton, 1990, p. 169; Robinson, 2014). Purposive sampling are non-random sampling methods commonly used in qualitative research to ensure that relevant categories of cases are represented within the sampling universe (Robinson, 2014). The logic and power of purposeful sampling (such as quota sampling) lies in selecting information-rich categories for in-depth investigation (Robinson, 2014). The rationale for adopting a purposive sampling strategy is based on the researcher's theoretical understanding of the topic, to ensure the presence of various categories of individuals with unique and important perspective (Mason, 2017; Robinson, 2014; Trost, 1986). The next paragraph describes a quota sampling which is a purposive strategy suitable for studies that employ multiple cases .

#### 3.6.5.6. Quota Sampling: suitable for multiple cases

Quota sampling is a purposive strategy suitable for multiple cases (Robinson, 2014). The process of quota sampling is a flexible strategy that sets out a series of categories and a minimum number of cases required for each one (Mason, 2017). The set minimum quota is monitored as the data gathering proceeds to establish both the set category and data saturation requirement. Minimum quota ensures that key groups are represented in the sample, while providing flexibility in both the final sample composition and a systematic recruitment process that is focused .

As a highlight in this study of inequalities in consumer MHealth innovation, the sample population of the PAB in the ROI considered the following categories of participants:

Sample selection in the PAB community targeting:

- Include at least 14 older adults (7 Males and 7 females, aged between 31-64 years)
- Include at least 4 younger adults (2 males and 2 females, aged between 18 to 30 years)
- Include at least People from 3 out of 4 Provinces of the ROI
- Consider Educational qualification (2 Secondary education, and 2 graduate level)
- Consider working class (2 Low and 2 highly paid employment)
- Consider family size living together (Below 3 Small and 2 large family 4 and above)
- Consider residential accommodation (2 in low and 2 high Neighbourhood)

The above criteria were suitably accommodated within a sample size of 25 individuals which was set as the provisional sample size for this study.

#### **3.6.6. Recruitment of Research Participants**

PAB community occasionally organises social and cultural forums, including group assemblies, such as social and religious gatherings. The researcher was very familiar with these forums and congregations of the PAB communities, and events. Through familiar connections, the researcher began to publicise the research through some members of PAB communities in the ROI. The researcher's familiarity with PAB and their community networks in the various Counties was helpful in spreading information. Through formal and informal introduction, the researcher spread the research information through some PAB individuals and their community members' networks. Information about the research was communicated with community

members so that interested individuals were able to contact the researcher for further information through shared telephone, email contact or personal contact.

#### 3.6.6.1. Voluntary Participation

The PAB individuals who showed interest were further contacted directly by the researcher for further discussion. During this personal face to face or telephone conversation, the researcher briefed the individuals with the participation details by referring to the Interview guide (Appendix B). The prospective participant was given information about the study aims, what participation entailed, the involuntary nature, how anonymity was enshrined into the process, and all other details that were helpful for them to reach informed decision. At this point the researcher explored the intimacy to share as much details as possible of the participation process using and handing out the information sheet (Appendix C). Furthermore, the researcher explored the intimacy to inquire about possibilities for more participants, especially those who lived within the same household. At the end of this discussion, and armed with the information sheet, the prospective participant was allowed time to think about his interest, and either accept or refuse. The researcher made sure the prospective participants were well informed about the research, including the researcher contacts and other relevant authorities such as the university College Cork. If the prospective participant decided to participate, s/he contacted the researcher directly or indirectly through phones call, email, text message or other available means to indicate interest to the researcher. When the prospective participant called the researcher and showed interest, the researcher and the prospective participant(s) decided a convenient date, time, and place for the follow up discussion and research activities involved.

#### 3.6.6.2. The Consent Form (Appendix D) in readiness for data collection 1 and 2

At the agreed date and time, the researcher arrived at the place agreed with the participant. The researcher began a preliminary introduction, by sharing the Information Sheet (Appendix C), which was handed to the participant to read and retain. After a successful reading of the information sheet and continued show of interest, the participant was given the Consent Form (Appendix D). After a careful reading, the participant was given the chance to decide, and if still interested s/he was required to sign the consent form to indicate interest to participate. The participant signs two copies of the consent form, retains a copy, and returns one copy to the researcher. After the consent form was signed the researcher commenced data collection protocols by following the interview guide. First, the demographic data collection, followed by the MHealth installation with TAP. When the MHealth was properly installed and working,

the researcher arranged to return to the participant after 8 weeks of use. Within the eight weeks of MHealth usage, the participants were advised to contact the researcher whenever they needed support for the MHealth. Please see details of data collection 1 and 2 in Section 3.8, and in the protocols for demographic data collection (Appendix E) and TAP (Appendix F).

#### 3.6.6.3. New participants

After the MHealth installation by using TAP, the ovation was high due to the fascination with the new MHealth device. The participants fascination created the opportunity for mutual communication with the researcher. The researcher inquired if the participant was willing to share information about the research, to show off the device, and to help to inform other prospective participants about the study. If the participant showed interest, the researcher handed out more information sheet to the participant with all the essential information for prospective PAB participants. In that way, the researcher recruited the informants who shared information with prospective participants.

It is important to note, that third party contact details were not sought directly from the participants by the researcher. The researcher only inquired if it was possible for the participant to share information about the research, and to share the researcher's contact details to potential participants (if they so wish to do so). A prospective participant was acknowledged whenever an individual (of his/her own interest) initiated contact with the researcher, by phone, text, or email or in person, for the purpose of the study.

#### 3.6.6.4. Recruitment Saturation

The above steps 1-3 are repeated until the needed sample size is accomplished, or the saturation is reached when no new information emerges from the interview. However, the researcher continued to engage other recruited PAB participants according to the agreed date, place, and time.

After data collections 1 and 2 were successfully concluded, and the eight weeks of usage had elapsed, the researcher returned to the participant for data collection 3 with RPD, and the interview. At the end of the interview the researcher shared the debriefing forms (Appendix I) with the participant to read and keep. This section ended the field work with an expression of gratitude and thanks by the researcher to the participant. More information of field work is presented in section 3.7.6, Also information about data collections 1, 2, 3, and 4 are presented in Section 3.8, and in the protocols for TAP and RPD (Appendix F).

### 3.7. Collection of Data

This section presents the data collection process. It starts in section 3.8.1 with an illustration of the data collection schedules, followed by a table of data collection activity with specific detail. Section 3.8.2 presents the data collection 1, and section 3.8.3, contains the data collection 2. Section 3.8.4. presents data collection 3, and section 3.8.5 contains the data collection 4. The management and treatment of the data is presented in section 3.8.6.

#### 3.7.1. Data collection schedule and activity table for day 1 and day 2

Getting ready for data collection in the field, the researcher prepared a schedule (Table 3.6) to highlight the chain of events to be carried out in day 1, and day 2 . The researcher labelled the four different phases of the data collection schedule for day 1 and day 2, including the eight weeks usage period before day 2 (Table 3.6).

Table 3.6 Data collection schedule

<b>Day #1</b>	
<b>Data Collection 1: Pre-implementation period of MHealth</b>	
<ul style="list-style-type: none"> <li>By using Face to face socio-demographic Survey of Participants collected</li> </ul>	
<b>Data Collection 2: Implementation of MHealth</b>	
<ul style="list-style-type: none"> <li>By direct observation of Participants installation of MHealth by using think-aloud protocol (TAP)</li> </ul>	
<b>8 weeks Break Period and use of MHealth</b>	
	
Take a break <b>Data collection break and usage period of MHealth for physical Activity and fitness [8 weeks]</b>	
<b>Day #2</b>	
<b>Data Collection 3: Post-MHealth usage period</b>	
<ul style="list-style-type: none"> <li>By direct observation of participant’s involving role play demonstration (RPD) with MHealth artefact (Abrahams-Gessel et al., 2015; Kerr, Troth, &amp; Pickering, 2020; Scotland, 2012, p. 12).</li> </ul>	
<b>Data Collection 4: Post-MHealth usage period</b>	
<ul style="list-style-type: none"> <li>Individual In-depth Semi-structured Interview</li> </ul>	
<b>End of data collection</b>	

The study was conducted in three Provinces of the ROI. At various dates according to the agreed schedule the researcher travelled to various locations in the provinces of the ROI to

meet the participants. The various locations include cork in Munster, Dublin in Leinster, and Galway in Connaught. This aspect of the study involved a total of 24 surveys questionnaires with individuals of PAB from 12 households, between July 2019 and March 2020. Table 3.7 represents the sequence of events during the data collection and how each activity fits into the research study.

**Table 3.7 Data collection activity table represents how each activity fits into the study.**

Data collection schedule for (1) demographic data, (2) TAP, (3) RPD, and interview				
Project timeline	Data collection Method	Medium of Data Collection	Duration in minutes	Type of Data
<b>Day 1: Pre-implementation of MHealth</b>	<b>Data collection 1:</b> Demographic data collection	1.1: Questionnaire	5-10	Survey
<b>Day 1: Implementation of MHealth</b>	<b>Data collection 2:</b> Researcher’s direct observation notes and reports of think-aloud protocol (TAP) to record incidents encounters during participant’s installation of MHealth	1.2: TAP Installation • Incident tasks 1-22 • Observation notes 23-35	25-30	Qualitative
8 Weeks of MHealth Usage period before next visit	Notes of interactive voice, text, or chat communication of participant with researcher for Social and technical Support	Notes of communication	Covers 8 weeks usage period	Qualitative
<b>Day 2: Post-MHealth usage period</b>	<b>Data collection 3:</b> Researcher’s observation notes of Role play demonstration (RPD) of MHealth usage by participant	2.1: RPD Memos • Incident tasks 36-44 • Observation notes 45-62	4-5	Qualitative
	<b>Data collection 4:</b> Individual in-depth interview	2.2: Voice Recording on electronic device	20-30	Qualitative

### 3.7.2. Data Collection 1: Starting with Demographic Survey (Appendix E).

The data collection #1, on day 1 follows the schedule (Table 3.8).

**Table 3.8 Activity schedule for demographic data collection 1, by using survey**

Day 1 schedule 1 for data collection 1, for demographic data
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Project timeline	Data collection Method	Medium of Data Collection	Duration in minutes	Type of Data
<b>Day 1: Pre-implementation of MHealth</b>	1. Demographic data collection	1. Questionnaire	5-10	Survey

Data collection 1 involved the use of survey questionnaires for 24 PAB individuals from 12 households, between July 2019 and March 2020. The survey lasted between 5 to 10 minutes for each person. The face-to-face socio-demographic data survey questionnaire also contributed as part of data sampling tool .

On the first day (day 1) of the data collection, following a pre-arrangement with the participants on the date and time, the researcher arrived at the participant’s location (household). After introductory greetings and informal familiarization, the data collection 1 process began by following the procedure outlined in the interview guide (Appendix B). Firstly, each of the two PAB participants in the household were served with the information sheet and allowed the opportunity to read, understand and discuss any detail. Next, the consent form was served to each participant, and allowed the opportunity to read, understand, accept, or refuse participation. When the consent form was accepted and signed, the researcher followed the questionnaire procedure for collecting the demographic data from the participant.

The research questionnaire was designed to gather PAB participants’ characteristics which include information about age, gender, education, employment, race/ethnic identity, and ownership of technology resources such as mobile phone and internet connection. It was confirmed during demographic data collection that the participant owns a mobile phone with internet connection. Ddemographic data collection protocol is provided in Appendix E.

### 3.7.3. Data Collection 2: using TAP during MHealth Installation

**Table 3.9 Activity schedule for data collection 2 with think-aloud protocol (TAP)**

Day 1 schedule 2 for data collection 2 with TAP				
Project timeline	Data collection Method	Medium of Data Collection	Duration in minutes	Type of Data

<b>Day 1: Implementation of MHealth</b>	2. Researcher's observation notes of think-aloud protocol (TAP) to record incidents encounters during participant's installation of MHealth	1.2: TAP Installation <ul style="list-style-type: none"> <li>• Incident tasks 1-22</li> <li>• Observation notes 23-35</li> </ul>	25-30	Qualitative
8 Weeks of MHealth Usage period before next visit	Notes of interactive voice, text or chat from participant to researcher for Social and technical Support	Notes of communication	Covers 8 weeks usage period	Qualitative

The protocol during demographic data collection required that that the participant owned mobile phone with internet connection as a basic requirement for the participation. After the demographic data collection, the researcher then introduced the MHealth devices to the participants. The individual participant session for TAP was designed to last between 25 to 30 minutes period, thus avoiding problems relating to fatigue in TAP protocols (Lewis, 1982; Martin-Rodilla & Gonzalez-Perez, 2016).

3.7.3.1. Installation of MHealth by participant, with TAP: Implementation of with direct observation notes and report by the researcher.

The installation of MHealth required the PAB individual sitting down with the researcher, to discuss about the MHealth PAF equipment and introduces all the essentials elements and requirements. The installation of MHealth required mobile phone and internet connection as a basic requirement. The researcher gave the PAB participant the additional equipment required for the MHealth installation.

- The participant already has mobile phone and internet connection

The researcher provides every participant with the following additional devices:

- Activity tracker (Beurer-AS80), with the quick start guide (One item to each participant)
- Digital bathroom weighing scale (Sanitas-SBF70), with the quick start guide).
- One item to both participants because it is possible to assign up to 8 users to one digital bathroom weighing scale.

3.7.3.2. The researcher followed the following procedure:

- The MHealth devices were introduced to participants to give them a head start.
- The think-aloud protocol (TAP) was explained but not demonstrated to the participant

- Researcher directly observed the participant and noted important steps and progress.
- During installation and setup, the researcher observed, guided or assisted the participant whenever it became necessary (Lewis, 1982; Vedanthan et al., 2015).

Details of data collection by using TAP is provided in Appendix F.

### 3.7.3.3. After MHealth PAF installation

- After the installation of MHealth, the participant and the researcher collectively inspected the data display on the MHealth cockpit. The PAB data for PAF were captured by the MHealth PAF and stored in the system during installation. The MHealth PAF stored the PAF data of the PAB participant (Appendix F). The participants remained with the MHealth PAF devices and continued to participate in the PAF for a duration of eight (8) weeks, before the researcher return to the participant for the next phase, the data collection 2. During the 8 weeks (Table 3.10), the participants were requested to communicate with the researcher whenever they needed support for the MHealth PAF.

**Table 3.10 Period for researcher to returns to participant after 8 weeks of usage**

<i><b>USAGE PERIOD FOLLOWS</b></i> <i>(AFTER DEMOGRAPHIC SURVEY AND TAP</i>	<i><b>8 WEEKS OF MHEALTH</b></i> <i><b>USE AND EXPERIENCE</b></i>
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The researcher returned to participants to commence data collection after they have used MHealth for 8 weeks. Another data collection commences (section 3.8.4) by using RPD (Appendix A) and finally conducting individual in-depth interviews (Appendix G) for each PAB participant (Section 3.8.4).

### 3.7.4. Data collection 3: using RPD at MHealth usage phase (Appendix F).

After the 8 weeks usage of MHealth PAF, the researcher returned to the participant to first execute the RPD, and secondly the individual interview. Table 3.11 contains the activity schedule for data collection 3 with RPD protocol.

**Table 3.11 Activity schedule for data collection 3 with RPD protocol**

Day 2 Schedule 1 for data collection 3 with RPD				
Project timeline	Data collection Method	Medium of Data Collection	Duration in minutes	Type of Data

<b>Day 2: Post-MHealth usage period</b>	3. Researcher's observation notes of Role play demonstration (RPD) of MHealth usage by participant	3. RPD Memos <ul style="list-style-type: none"> <li>• Incident tasks 36-44</li> <li>• Observation notes 45-62</li> </ul>	4-5	Qualitative
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The RPD required the participant to demonstrate the various use cases involved during the use of MHealth, and the reading of personal data from the cockpit of the MHealth screen display (Appendix F). RPD required the direct involvement of the participant in a role-play for demonstration of his/her activities with MHealth artefact during MHealth usage period (Abrahams-Gessel et al., 2015; Kerr, Troth, & Pickering, 2020; Scotland, 2012, p. 12).

PAB participant was asked to demonstrate how she/he used the MHealth PAF during the eight weeks of usage. Details of the RPD is provided in the Appendix F. RPD section lasted about five minutes and was carried out before the in-depth interview began. The RPD involved the direct observation of participant's MHealth use experience by using role-play demonstration (RPD). Participant's role-play with MHealth technology artefacts included activities such as MHealth data readings, screenshot photo images of MHealth usage and performance display (Appendix F). Again, the aim of the role-play was to illuminate the PAB interactions, which were situated in practice, and to discover that knowledge that were mainly observed but absent from other documentation (Akama et al., 2007; Suchman, 1987; Vyas et al., 2009).

### 3.7.5. Data Collection 4: In-depth interview after MHealth usage experience

After the RPD, the researcher switches over to the interview by using the interview questions in Appendix G. Table 3.12 contains the activity schedule for data collection 4 with individual in-depth interview.

**Table 3.12 Activity schedule for data collection 4 with individual in-depth interview**

Day 2 schedule 2 for data collection 4, with in-depth interview				
Project timeline	Data collection Method	Medium of Data Collection	Duration in minutes	Type of Data
<b>Day 2: Post-MHealth usage period</b>	4. Individual in-depth interview	4. Voice Recording on electronic device	20-30	Qualitative

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The individual in-depth interviews were executed by following the interview protocol. Each of the individual in-depth interview was audio recorded, with an electronic device according to the interview protocol. The detail of the individual interview questions is contained in Appendix G. At the end of the interview, the debriefing form was administered to every PAB participant by the researcher in accordance with the interview guide (Appendix B). At this time, the face-to-face in-depth interviews involved 22 PAB participants, while the remaining two PAB interviews were conducted through telephone communication.

### 3.7.6. Management and treatment of the collected data

At this point all data (phase 1, 2, 3, and 4) were collected. Therefore, the researcher had the custody of the, following: 1. demographic survey data, 2. direct observation notes and report of TAP installation, 3. direct observation notes and reports of RPD demonstrations, and 4. the audio recording of individual in-depth interview. The researcher organised all these data and the corresponding documentation in preparation for data analysis. The information (Table 3.13) provides some record of events with PAB participants during data collection.

**Table 3.13 Completed data collection activity with location and dates.**

Data collection Table with location and dates for demographic, TAP, RPD and interview PI represents- pilot interview, and TI represents - telephone interview.							
SN	Location	Code Name of Participant	Demographic DD/MM/YY	TA Protocol DD/MM/YY	RP Demo DD/MM/YY	Interview DD/MM/YY	Remarks
1	CORK	01. CORK 1.1 JE	15/07/19	15/07/19	15/09/19	15/09/19	PI
					8/02/2020	08/02/20	Repeat
2	CORK	02. CORK 1.2 SE	28/10/19	28/10/19	26/11/19	26/11/19	
3	CORK	03. CORK 2.1 CD	02/10/19	02/10/19	02/12/19	02/12/19	
4	CORK	04. CORK 2.2 FD	02/10/19	02/10/19	02/12/19	02/12/19	
5	CORK	05. CORK 3.1 TE	03/10/19	03/10/19	12/12/19	12/12/19	
6	CORK	06. CORK 3.2 KE	03/10/19	03/10/19	12/12/19	12/12/19	
7	CORK	07. CORK 4.1 DU	08/08/19	08/08/19	14/12/19	14/12/19	
8	CORK	08. CORK 4.2 AU	11/08/19	11/08/19	15/10/19	15/10/19	
9	GALWAY	09. GALWAY 5.1 JU	08/01/20	08/01/20	27/02/20	27/02/20	
10	GALWAY	10. GALWAY 5.2 LU	08/01/20	08/01/20	27/02/20	27/02/20	
11	GALWAY	11. GALWAY 6.1 KO	08/01/20	08/01/20	27/02/20	27/02/20	
12	GALWAY	12. GALWAY 6.2 GO	08/01/20	08/01/20	27/02/20	27/02/20	
13	GALWAY	13. GALWAY 7.1 EA	08/01/20	08/01/20	27/02/20	27/02/20	

14	GALWAY	14. GALWAY 7.2 EA	08/01/20	08/01/20	27/02/20	27/02/20	
15	GALWAY	15. GALWAY 8.1 ON	08/01/20	08/01/20	27/02/20	27/02/20	
16	GALWAY	16. GALWAY 8.2 LN	08/01/20	08/01/20	27/02/20	27/02/20	
17	DUBLIN	17. DUBLIN 9.1 PG	17/01/20	17/01/20	07/03/20	07/03/20	
18	DUBLIN	18. DUBLIN 9.2 EG	17/01/20	17/01/20	07/03/20	07/03/20	
19	DUBLIN	19. DUBLIN 10.1 CF	17/01/20	17/01/20	07/03/20	07/03/20	
20	DUBLIN	20. DUBLIN 10.2 AF	17/01/20	17/01/20	07/03/20	07/03/20	
21	DUBLIN	21. DUBLIN 11.1 OC	17/01/20	17/01/20	07/03/20	07/03/20	
22	DUBLIN	22. DUBLIN 11.2 EC	17/01/20	17/01/20	07/03/20	07/03/20	TI
23	DUBLIN	23. DUBLIN 12.1 NA	17/01/20	17/01/20	07/03/20	07/03/20	
24	DUBLIN	24. DUBLIN 12.2 CA	17/01/20	17/01/20	07/03/20	07/03/20	TI

Once the interviews were completed the researcher organised all the materials involved during the data collection. Also, the individually signed consent forms of the PAB participants and the data documents were arranged.

A total of 72 documents were collected from the 24 PAB participants in this research. All PAB participants were actively involved in all the four phases of data collection protocols.

The 72 data documents include:

- demographic survey of 24 documents.
- combined direct observation notes and report TAP and RPD, of 24 documents.
- individual in-depth interview transcript of 24 documents.

A total of 72 documents of data from PAB participants were loaded into the NVivo QDAS and organised with other data collection documents (Walls et al., 1992; Zamawe, 2015). The audio interview recordings were then transcribed verbatim with the help of the NVIVO software. At this point, all identifying information in the documents were removed and anonymized by the researcher. The transcription and anonymization followed the procedure prescribed for data management in the approved protocol by the SREC, which was also communicated to the participants in the information sheet (Appendix C). Details of the data transcription and other data management requirements including data protection and anonymity of transcripts were maintained in accordance with European Union (EU) General Data Protection Regulation (GDPR) (Recital 26) and detailed in the ethical approval granted by the Social Research Ethics Committee (SREC), of the University College Cork.

### 3.8. The Data Analysis

This section contains the detail of the quantitative and qualitative data analysis process. The demographic data was analysed quantitatively and the direct observational notes and report of

TAP and RPD, as well as the interview transcripts were qualitatively analysed using NVivo QDAS. The qualitative data was concurrently analysed by using the grounded theory methodology. Section 3.9.1 contains the analysis of demographic data, followed by the analysis of qualitative data in section 3.9.2. Section 3.9.3 focused on open coding posited by , section 3.9.4 focused on axial coding, and section 3.9.5 focused on selective coding. The robustness of naturalistic research and validation of qualitative analysis involved in this research are highlighted in section 3.9.6.

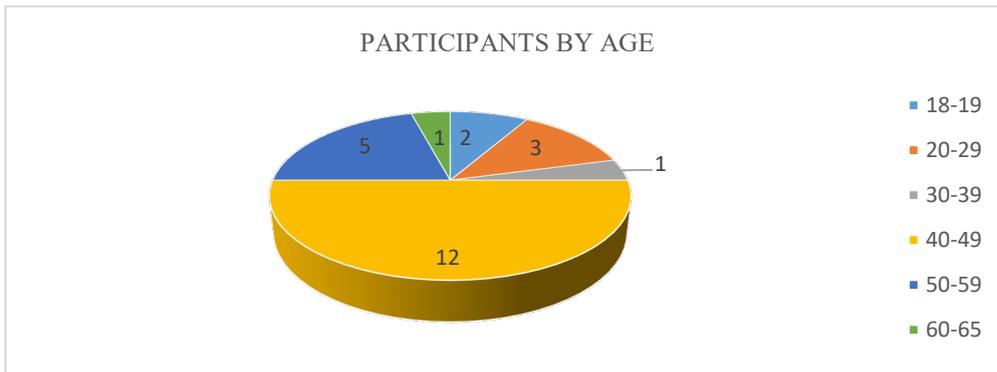
### 3.8.1. Analysis of demographic data

The result of the demographic data analysis revealed the characteristics of the PAB participants. The demographic data instrument recorded details of 24 PAB participants from 12 households across three Counties of the ROI. The 24 participants included individuals ranging between the ages of 18 to 64 years, comprising of male (9) and female (15). The PAB population comprised of various occupational groups, such as professionals, in education, health, and other fields (7). Other occupational groups include students (5), self-employed (5), and those working in manufacturing sectors such as pharmaceutical industries (7). Table 3.14 represents the quantitative characteristics of PAB participants.

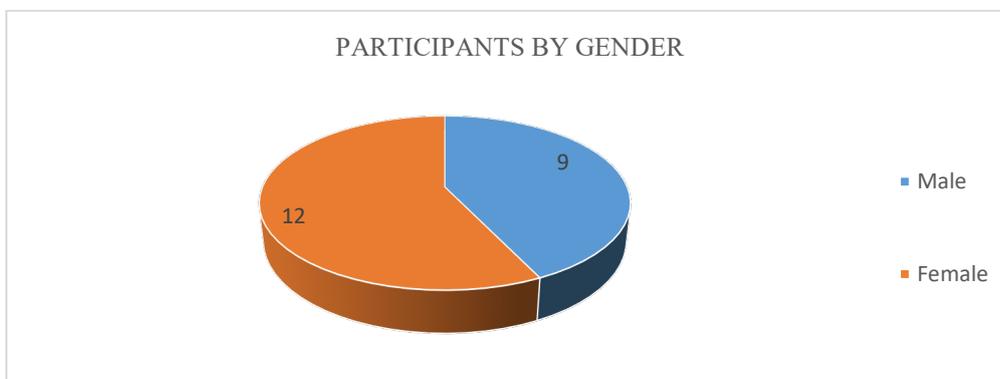
**Table 3.14 Quantitative characteristics of PAB participants**

<b>Age</b>	<b>Gender</b>	<b>Education</b>	<b>Employment</b>	<b>Location</b>
<i>18-19 (2)</i>	<i>Male (9)</i> <i>Female (15)</i>	<i>Secondary (2)</i>	<i>Professional (7)</i>	<i>Cork (8)</i>
<i>20-29 (3)</i>		<i>College (12)</i>	<i>Student (5)</i>	<i>Dublin (8)</i>
<i>30-39 (1)</i>		<i>University Undergraduates (6)</i>	<i>Self-employed (5)</i>	<i>Galway (8)</i>
<i>40-49 (12)</i>		<i>University Postgraduates (4)</i>	<i>Manufacturing (7)</i>	
<i>50-59 (5)</i>				
<i>60-65 (1)</i>				

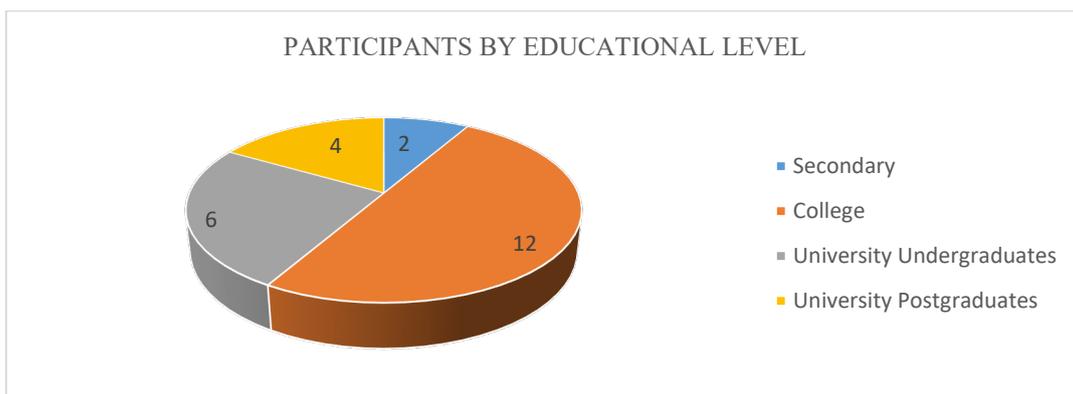
Further analyses were derived from the PAB characteristics in Table 3.14 and inserted from the Microsoft word chart. Figures 3.5, 3.6, 3.7, 3.8 and 3.9 derive from the quantitative characteristics of PAB participants in Table 3.14. Figure 3.10 represents the PAB participants' employment and educational characteristics analysed with NVIVO QDAS.



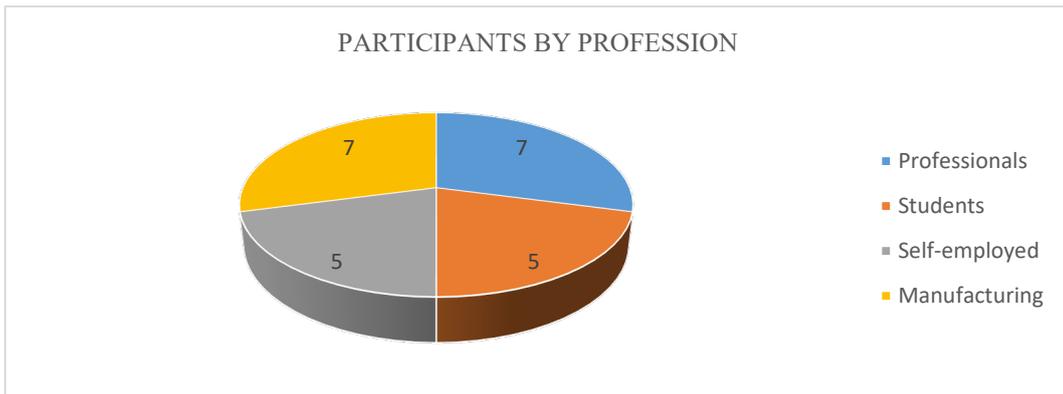
**Figure 3.5 Information of the participants by age**



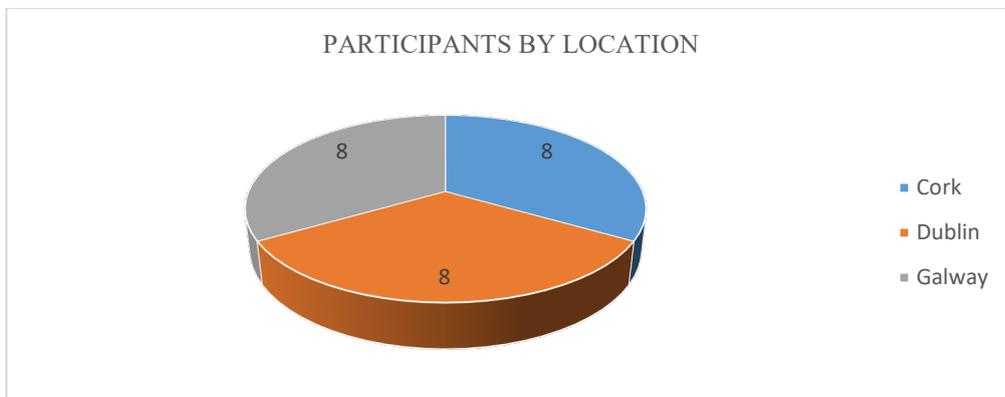
**Figure 3.6 Information of participants by gender**



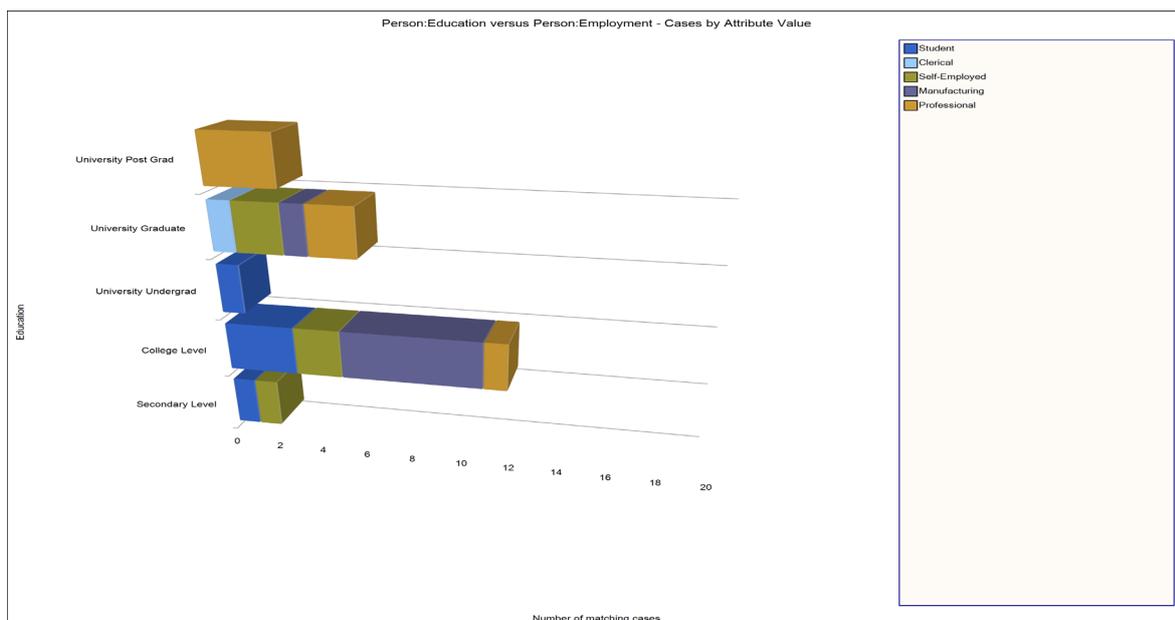
**Figure 3.7 Information of participants by educational level**



**Figure 3.8 Information of the participants by profession**



**Figure 3.9 Information of participants by location**



**Figure 3.10 Participants' employment and education (from NVivo QDAS)**

### 3.8.2. Qualitative Data Analysis

The 72 documents from the PAB participants were already loaded into the NVIVO QDAS. This section describes the qualitative data analysis process with the use of grounded theory posited by Strauss and Corbin (1990), and the concurrent use of the NVIVO QDAS. The PAB documents were qualitatively analysed by discovering codes and by looking for all possible interpretations of the words, phrases and sentences (Moghaddam, 2006).

Qualitative data analysis or coding with grounded theory methodology is a process that uses conceptual abstraction, by assigning concepts (codes) to incidences or events drawn from respondents' interviews and observation notes (Kaiser & Presmeg, 2019; Moghaddam, 2006). The grounded theory process extract from the data, implicit concepts of how relevant psychological or social phenomenon occurs, to make them explicit or known by explanations using theory (Kaiser & Presmeg, 2019; Moghaddam, 2006). The Strauss and Corbin (1990), grounded theory methodology is a systematic and rigorous process for the analysis of qualitative data. defined a theory as "a set of relationships that proposes a reasonable explanation of the phenomenon under study" . The coming sections introduce the coding concept of the qualitative data analysis process and gradually delves into the grounded theory methodology espoused by (Strauss & Corbin, 1990).

#### 3.8.2.1. Grounded theory methodology: Transpose data to conceptualization or codes

The data in the form of words and expressions of the participants are symbolic, in the sense that they do not stand for themselves, but for a hidden content yet to be explored and explained. Qualitative data analysis generally derive from distinctive approach by emphasising two types of relationships based on similarities and contiguity (Maxwell & Miller, 2008). The analytical emphasis is on the alignment or tensions in the relationship between the words, phrases, or language. Qualitative data analysis are deeply rooted in the contextual richness of the phenomenon and seeks to establish a clear chain of evidence as part of the written result (Benbasat et al., 1987; Eisenhardt, 1989). Coding is an analytic process by which data are broken-down, or "fractured, conceptualised, and integrated to form theory" (Moghaddam, 2006) Coding aims to search and recognise, develop and relate the concepts that form the building blocks from story to theory (Moghaddam, 2006).

#### 3.8.2.2. Grounded Theory Methodology: Inductive transposition of specifics to theory

This research follows the grounded theory methodology to investigate inequalities in consumer MHealth. The grounded theory follows a more inductive approach to coding which is grounded

in data without a preconceived insight (Bradley, Curry, & Devers, 2007). Inductive analysis is a process of new discovery which is conceived from specifics in the observations of data and emerging to a broader generalization of theory (Eisenhardt, 1989; Gioia et al., 2013). The rationale for using the grounded theory is based on qualitative research paradigm, and assumptions recommended by qualitative researchers (Moghaddam, 2006; Star, 1998; Strauss & Corbin, 1990). The researcher highlights the rationale for using grounded theory as the right methodology to guide the study of inequalities in consumer MHealth (Goulding, 1999; Moghaddam, 2006; Strauss & Corbin, 1990). Table 3.15 contains the rationale for using grounded theory methodology to interrogate the data for inequalities in MHealth

**Table 3.15 Rationale for using grounded theory methodology**

Rationale for using grounded theory to interrogate data for inequalities in MHealth			
	Rationale of grounded theory	Relevance to MHealth in/equality	Reference
1	Study requires going to the field to discover what is really going on	√	Strauss & Corbin, 1998; Moghaddam, 2006
2	Study contributes to the relevance of theory to the development of a discipline.	√	Strauss & Corbin, 1998; Moghaddam, 2006
3	Study involves the complexity and variability of phenomena and of human action.	√	Strauss & Corbin, 1998; Moghaddam, 2006
4	Study involves the belief that persons are actors responding to problematic situations.	√	Strauss & Corbin, 1998; Moghaddam, 2006
5	Study assumes that person's act based on meaning.	√	Strauss & Corbin, 1998; Moghaddam, 2006
6	Study revolves around the understanding that meaning is defined and redefined through interaction.	√	Strauss & Corbin, 1998; Moghaddam, 2006
7	Study involves sensitivity to the evolving and unfolding nature of events or process.	√	Strauss & Corbin, 1998; Moghaddam, 2006
8	Study involves awareness of the interrelationships among conditions (structure), action (process), and consequences	√	Strauss & Corbin, 1998; Moghaddam, 2006
9	Study requires empirical approach to data collection and analysis	√	Star, 1998; Moghaddam, 2006
10	Study requires a constant comparative approach to theory development	√	Star, 1998; Moghaddam, 2006
11	Study requires theoretical sampling rather than site or population driven	√	Star, 1998; Moghaddam, 2006
12	Study requires developing a theory that works from substantive evidence through to formal levels using constant comparison technique	√	Star, 1998; Moghaddam, 2006

13	A review of the pertinent literature reveals no current thinking in the area, nor any meaningful hypotheses on the subject	√	Strauss & Corbin, 1998; Moghaddam, 2006
14	Applying grounded theory to the areas where an extensive, reliable, and empirically based literature exists may cause some difficulties.	√	Goulding, 1999; Moghaddam, 2006
15	Researcher entered the field with original insight because there was no preconception or even existence of hypothesis of the area before entering the field, whether researcher is aware of it or not.	√	Goulding, 1999; Moghaddam, 2006
16	Throughout the course of the research, it is common to gather an extensive amount of data in various forms such as interview transcripts, field notes on observations, memos, diagrams, and conceptual maps.	√	Moghaddam, 2006

### 3.8.2.3. Qualitative data analysis of inequalities in consumer MHealth

It is further established in Table 3.15 that inequalities in consumer MHealth is the type of data that require inductive approach and grounded in data (Corbin & Strauss, 1990; Zamawe, 2015). Qualitative data analysis practically involves a process of reading each document line-by-line and selecting suitable themes, words, or paragraphs. The qualitative coding process involves breaking-down the bulk of information evidence into their component parts, in order to distinguish the various elements described by the participant relating to the MHealth phenomenon (Kennedy, Rogers, & Bower, 2007). The breaking down analogy is used here to portray the data analysis process which is also designed to distinguish the component parts or the building blocks of the MHealth phenomenon. The objective of coding in qualitative analysis is to identify, in the words of the participants, what comprise the differences or factors of inequalities in the MHealth phenomenon.

### 3.8.2.4. Inequalities portray unfair differences in the MHealth

The data analysis process is required to address the research objective and research questions presented in Chapter 2. The literature review in chapter 2 described inequalities in MHealth as a notion of the “*differences that are unfair, unjust, unnecessary and avoidable*”, exemplified by MHealth innovation (Arcaya et al., 2015; Graham, 2009; Gerry McCartney et al., 2013; Weiss & Eikemo, 2017). Fundamentally, the coding process is a breaking down of data to search for differences in the experiences and related circumstances of the PAB participants in their MHealth experiences. The differences to be derived from data are implicated in the narratives with which the PAB participants describe their MHealth experiences. Similarly, these differences in their experiences are also implicated in their description associated to the subcomponents or building blocks of the MHealth phenomenon.

### 3.8.2.5. Building blocks of MHealth are implicated in the PAB experiences

Again, the ontology of the MHealth phenomenon is concerned with the structure and properties of “what is assumed to exist” (Iivari et al., 1998). For this phenomenon, the ontology comprises of the “basic building blocks” that make up the MHealth phenomena under investigation. Again, information systems (IS) describe an “arrangement of people, data, and information technology that interact to capture, process, store, and communicate” to provide information needed to support a business organisation (Iivari et al., 1998; Orlikowski & Baroudi, 1991). Similarly, MHealth system is an IS system which compose of: “people, processes, data, IT, networks, information, and organisations” (Iyawa et al., 2016; Morley & Floridi, 2019; Serbanati et al., 2011). Therefore the “basic building blocks” of MHealth phenomena involve people, IT and networks, organizations, processes, data and information (Walls et al., 1992). These MHealth building blocks are implicated in the participants’ narratives which portray their “differences” in their or inequalities in MHealth experiences (Iyawa et al., 2016; Labrique, Vasudevan, Chang, & Mehl, 2013; Morley & Floridi, 2019; Serbanati et al., 2011).

### 3.8.2.6. Measures of inequalities are implicit in PAB interaction with MHealth

As a form of strategy to apply the grounded theory approach, the measures of inequalities or differences are implicit in the MHealth phenomenon. The elements which characterise the MHealth phenomenon were also broken-down into multiple components comprising of sub elements, defined by IS components: IT, networks, people, data and information, communication processes, and organisations . The subcomponents of MHealth phenomenon and other elements yet to be identified in the data, represent the beginning point for understanding the events, circumstances, context, and how they relate with inequalities and the meaning it holds for PAB participants.

### 3.8.2.7. Basic elements of grounded theory are concepts, categories, and propositions

The three basic elements of grounded theory are concepts, categories, and propositions . Concepts are the basic units of analysis, and the coding process starts from conceptualization of data, thereby transforming the actual data through conceptualization. The conceptualization of data into codes require an understanding of the MHealth phenomenon to help make meaning for the open codes. The open codes can be conceptualized and contextualised by reference to the sub elements of the MHealth IS characteristics. These sub elements, such as technology system, IT, networks, people, information, and communication processes provide the context which serve as templates for interpreting the data. The MHealth building blocks provide

context which help to conceptualise data into codes. The building blocks of MHealth serve as coding template and are organised with their corresponding relativist stance of the constructivist paradigm, shown in Table 3.16.

**Table 3.16 Building blocks of MHealth IS used in the analysis of data**

MHealth building blocks as coding template for understanding the MHealth phenomenon, and links for data to context, concept and to open codes. Table from: Iivari et al. (1998), adapted for this study	
<b>MHealth/IS component</b>	<b>Constructivist Interpretation of Relativist</b>
<b>information Systems networks</b>	sociotechnical systems realizing human intentions
<b>information technology</b>	malleable structures: based on social and human choice
<b>people as individuals, or groups</b>	Individuals who voluntarily interpret IS events based on their own context
<b>Data and information</b>	socially constructed meanings
<b>Communication processes</b>	Interactions and transactions
<b>organisation &amp; society, culture, influences</b>	interaction systems or socially constructed systems (nominalism)

### 3.8.3. Grounded theory: Open Coding posited by Strauss and Corbin (1990).

The data analysis in this thesis followed the coding process developed by for grounded theory data analysis. The coding procedure developed by occur in three phases: 1. open coding, 2. axial coding, and 3. selective coding. Open coding is usually the first in the sequence (Strauss & Corbin, 1990). However, the three procedures of coding do not occur in a strict sequence. The coding process involves the analytic process of comparison, and going forth and back to integrate relevant factors (Pandit, 1996).

#### 3.8.3.1. Open Coding: From data to concept as the basic unit of analysis or coding

Open coding is a qualitative data analysis process of identifying concepts as the basic unit of analysis, before going further to discover their properties and dimensions . The coding process requires the researcher to be conscious of the expressions of the interviewee in terms of their words, phrases, themes, sentences and paragraphs that highlight important issue about the MHealth phenomenon . The identified concept about the phenomenon is consequently noted

and described in a short phrase, or code (Moghaddam, 2006). Analysis literature states that that, open coding is the part of data analysis that focuses on the conceptualisation, before proceeding to categorisation of phenomena (Heath & Cowley, 2004). Open coding involves conceptualisation through intensive analysis or breaking down and comparison of the data.

3.8.3.2. Concept is the basic building block of theory described as abstract reflection of event, object, action, or interaction

Open coding is seen as a micro analysis of data, word-by-word and line-by-line, and coding the meaning found in those words or group of words (Allan, 2003). This kind of data coding, according to Dey (2003), involves breaking down data in order to conceptualise and then categorise the concepts derived, and consequently make connections between these concepts to provide basis of fresh description (Dey, 2003, p. 30; Walker & Myrick, 2006). Concepts are the basic building blocks of theory, described as an abstract illustration of an event, object, action or interaction (Goede & De Villiers, 2003; Moghaddam, 2006). The act of conceptualizing is an abstraction, where data are broken down into discrete incidents, ideas, events, and acts and are then given a name in the form of code that represents or stands for them . According to . The choice of words or code may be one placed on the objects by the analyst because of the imagery or meaning they evoke when examined comparatively and in context, or the name may be taken from the words of respondents themselves .

3.8.3.3. Constant comparison of data and codes to identify similarities and/or differences.

The two core elements of open coding are: posing sensitizing questions and constantly comparing data and codes to identify similarities and/or differences. Open coding involves breaking up the data into smaller parts by reading every word, and lines of the transcript, and identifying passages of texts, words, phrases or section to ascertain and grasp the main idea in each part, and to assign a code or a conceptual label to describe it (Corbin & Strauss, 1990). The emerging codes are indicative of actions, events, or interactions which are reflective of the data and the phenomenon (Allan, 2003; Maxwell & Miller, 2008). Again, these smaller analytical parts are compared with respect to their similarities and differences, and similar parts are labelled with the same concept. Open coding aims to develop a wealth of codes with which to describe the data by posing sensitizing questions regarding the data during analysis .

3.8.3.4. Concept, Codes, Commonalities and Categories

According to Strauss and Corbin (1990), concept denotes a phenomenon or event which is conceptualized in two levels, by, firstly assigning each concept to one code, and then

comparing each concept in turn with all other concepts. Consequently, the open codes are conceptualised in a context, and organised according to their commonalities so that categories of a higher order emerge .

#### 3.8.3.5. Eliciting discovery of important concepts through question

Qualitative researchers believe events are intricately linked with time and place as well as to people. To elicit discovery of important concepts from data, Strauss and Corbin (1990) opines that grounded theory procedures require the researcher to explore a range of questions, about, what power is in the situation, and under conditions? recommends discovery questions in terms of “how is it manifested, by whom, when, where, how, with what consequences (and for whom or what)?” (Moghaddam, 2006). Studies show that qualitative researchers derive enriched interpretation of the data by following some lines of questioning (Kaiser & Presmeg, 2019; Strauss & Corbin, 1990). Literature shows that researchers follow several lines of questioning targeting various aspects of the phenomenon to elicit concept. Qualitative researchers suggest that the lines of questioning can be diverse, and authors have followed several and unrestricted lines of questioning in the form of:

- What is the phenomenon describing?
- Who are the people involved, and which roles they play?
- How are aspects of the phenomenon dealt with or those left out?
- When, how long, and where, to identify spatial and temporal significance of events?
- Why, for justifications?
- Whereby, of the strategies used.
- What consequences are anticipated?

These sensitising questions, were suggested to be helpful for researchers to dive into data to uncover the descriptions of relevant events of the occurrence of the phenomenon (Kaiser & Presmeg, 2019; Strauss & Corbin, 1990).

The researcher in this study embarked on diverse lines of questioning to elicit concepts for the analysis of PAB data. The MHealth characteristics were helpful tools which the researcher explored to elicit concepts from data. Table 3.16 represent the subcomponents of MHealth which the researcher elaborated and used as interrogation templates and reflective tools for contextualising and conceptualizing the data.

### 3.8.3.6. Open code extracts from the open code book

The researcher in this study followed the grounded theory approach espoused by Strauss and Corbin (1990), for questioning and inductively analysing PAB data. In addition to the grounded theory methodology, the researcher concurrently used the NVivo-12 qualitative data analysis software (QDAS) in the open coding process. The researchers progress during the open coding were captured and organised in Microsoft-Excel sheet, with their corresponding questions, and the participants' responses. Again, the open codes represent the name assigned to concepts derived from words, phrases, themes, and paragraphs from the PAB data. Table 3.17 represents extracts of open codes from PAB interview, TAP and RPD data.

**Table 3.17 Interview questions, the corresponding open codes and transcriptions**

Sample of Code Book Extracts [Codes are Assigned to Themes]		
Interview Question	Transcription Contains individual experience in terms of cognitive, affective, behavioural, and environmental factors during interactions with MHealth (Strauss & Corbin, 1998)	Open Code (Concept representing, or being an example of)
<b>Q1.1</b>	What do you understand as the risk associated with lack of exercise or sedentary lifestyle that is sitting in a place for a long time? You can narrate from here now.	
	<b>23. DUBLIN 12.1</b> Sitting in a place for a long time or lack of exercise can cause one to be obese. It can also trigger some risk factors associated with maybe diabetes or high blood pressure and then so it is very, very You know, good to for someone to actually put in at least 30 minutes a day, as part of exercise just to keep fit, even when you think you're very healthy, or you're healthy.	need for MHealth because of sedentary health risk
<b>Q2.3</b>	What do you recall as key usefulness of the health coach app, that is what things the app helps you to do, which you could not do without the app.	
	<b>23. DUBLIN 12.1</b> Without the app I couldn't exercise the more, you know, the much I did. Without the apps I couldn't take as much water that I'm taking now. I don't like taking water.	need for MHealth because it helped to improve self-care
<b>Q6.0</b>	Considering what you know now, what do you perceive as the importance of the use of mobile health for you and for your family perhaps?	
	<b>23. DUBLIN 12.1</b> And actually, almost everyone in my house needs one. Because like I said, my husband, he has high blood pressure, high cholesterol level. So, these we help track it down.	need for MHealth because it helped to improve self-care
	<b>23. DUBLIN 12.1</b> The only information I need to share is I need to keep this (i.e., to retain the device).	ownership of equipment for MHealth access
<b>REPORT 56</b>	Reciprocity for participant participation	
	<b>01. CORK 1.1. INCIDENT REPORT</b> The participant was full of enthusiasm, and he requested to continue with the MHealth and specifically requested to keep the devices. However, I could only allow him to keep only the Activity tracker for his interest and as reciprocity for participation.	ownership of equipment for MHealth access
	<b>3. DUBLIN 12.1. INCIDENT REPORT</b> The participant requested to continue with her activities and emphasized that she could not replace the devices	ownership of equipment for MHealth access

<b>REPORT</b>	<b>01. CORK 1.1. INCIDENT REPORT</b> Please note prior to MHealth implementation the participant was encouraged and equipped with the MHealth artefacts. Ownership of mobile telephone and internet connection were prerequisites (see demographic data), the Health coach app was downloaded, and MHealth devices were supplied to the participant include “Beurer Activity Sensor AS80, and Sanitas digital weighing Scale SBF70”. These resources enable access to the various services provided by MHealth.	ownership of equipment as a requirement for MHealth implementation
<b>Q9.1</b>	<b>Do you have any other information to share in this interview?</b>	
	<b>01. CORK 1.1</b> No the information I can share with you this is very good. So, it would be good to get more people to know it	creating MHealth awareness
<b>REPORT 46</b>	<b>Severity of illness is made observable in colours: .01 Under-Weight; .02 Normal Weight; .03 Over-Weight; .04 Obesity</b>	
	<b>23. DUBLIN 12.1. INCIDENT REPORT</b> The participant identified her health status and stated in RPP Field Report 46: showing the severity of illness is made observable in colours	knowledge that MHealth creates awareness of health status

### 3.8.3.7. MHealth subcomponents as interrogation template to interpret the open codes

The researcher needed insight to make meaning or derive some patterns in the open codes. Inspiration for patterns was derived from the researcher’s data collection notes and reports during the data collection process. The researcher’s notes and reports during the data collection provided further guidance to the researcher for understanding the PAB narratives and conceptualizing the codes. The researcher’s notes and reports during the data collection encompass the three stages of MHealth which started from pre-implementation to implementation, and up to usage period of the MHealth. For the researcher, the data collection process was a learning opportunity which provided insight into the MHealth phenomenon through the various stages of data collection. The data collection process was also a great opportunity for the researcher to familiarise with the workings of the MHealth technology and all the implicit processes involved. It was therefore relevant for the researcher to draw insight from the various phases of data collection processes, and from the activities of PAB participants with the MHealth phenomenon.

Moving further with the coding process, required the researcher to select a template to understand the MHealth phenomenon. Again, the MHealth template derive from the interaction of people, data, processes, and IT (Walls et al., 1992). From the researcher’s perspective, the patterns in the code reflect the MHealth phenomenon. The outcome of the open codes from PAB data reflected issues pointing to patterns corresponding to the arrangement of “people, data, processes, IT hardware, IT software, voice networks, information, and the context . Although new patterns continued to emerge in the coding process, but all the patterns fall within the sub elements of the MHealth phenomenon.

3.8.3.8. Inequalities in MHealth is represented in the differences expressed in PAB experiences and in relation to MHealth-IS characteristics

The researcher found that inequalities in consumer MHealth PAF were represented as a function of the differences in the composite factors. For example, inequality in MHealth is a function (x), where x is the systematic differences that exist in the MHealth characteristics. The researcher went further from conceptualisation to discovering that these concepts were reflective of patterns in the various elements contained in the MHealth PAF characteristics. At this stage of the coding process, elaboration of the MHealth characteristics was required to capture the differences implied in the PAB narratives. The researcher applied the IS characteristics as a coding template to interrogate and cross-examine the PAB data, to capture their descriptions of how the disparities are inextricably intertwined with what they know and think of MHealth, and how they feel, react, or behave about the phenomenon. Table 3.18 represents the elaborated components of MHealth information systems with its characteristics which gave insight into the elements indicative of inequalities or “measures of differences” of the MHealth phenomenon.

**Table 3.18 Elaborated MHealth-IS components as coding template for data interrogation**

MHealth IS used as template for interrogation for differences in the sub elements			
MHealth information system is described as “an arrangement of people, data, processes, and IT that interact to collect, process, store, and provide as output the information needed to support an organisation (Whitten & Bentley, 2007, p6; Klein & Myers, 1999) and elaborated as a template for interrogation in search of differences in the sub elements			
“IS” Component	Meaning	Some “IS” Characteristics that may account for systematic (unfair and avoidable) differences	Ref
<b>People</b>	Stakeholders of information system (owners, users, designers, builders)	Factors relevant to user customers (stakeholder) include time, language, knowledge, cost, value, benefits, functionality, usability, usefulness, ease of use, socioeconomic and demographic factors	Iivari et al., 1998; Burrell & Morgan, 1979
<b>Data</b>	“Raw facts about people, places, events, and things that are of importance to organisations. Each fact is, by itself meaningless...”	Business facts about products, employees, customers, etc. factors relevant include input, process, and output	(Klein & Myers, 1999; Benbasat & Zmud, 2003).

<b>Processes</b>	an instance of a program being executed by a system in response to input data	Capture input, manipulate, store and communicate output	(Klein & Myers, 1999; Kaplan & Maxwell, 200)
<b>IT</b>	A contemporary term that describes the combination of computer technology with telecommunication technology	Computer technology hardware and software with telecommunication technology (data, image, and voice networks). Factors relevant include effectiveness	(Kaplan & Maxwell, 2005; Whitten & Bentley, 2007, p. 6)
<b>IT Hardware</b>	Physical parts of an IT system	Central Processing Unit (CPU), hard drive, memory, motherboard. Factors relevant include effectiveness	(Iivari et al., 1998; Ellul, 1965, p. 60; Orlikowski, 1992)
<b>IT Software</b>	Computer programs	Firmware, drivers, operating system, application etc. Factors relevant include effectiveness	(Kaplan & Maxwell, 2005)
<b>Networks</b>	Multitier system of computer communication Local Area Network (LAN). Wireless LAN (WLAN). Metropolitan Area Network (MAN). Wide Area Network (WAN). Storage-Area Network (SAN).	Interoperable digital network is the backbone of the web of global social relationships, integration and social ties that surround individuals that result to various social influence, companionship, capital, and support.	(Ivari et al., 1998; Goldkuhl & Lyytinen, 1982; Orlikowski, 1992; Giddens 1984)
<b>Information</b>	Data that has been processed or reorganised into a more meaningful form for decision making	Information for health decision e.g., minimum of 3000 steps/day of physical activity, normal body weight or body mass index (BMI). Health information has to be communicated and utilised for decision to improve knowledge, process and communication	(Iivari et al., 1998; Klein & Hirschheim, 1987; Hirschheim et al., 1995)
<b>Context, organisation, structure</b>	System environment	Environment may comprise individual, social, community, infrastructural, policy, national, international etc. Socioecological co-existential support is relevant in a context	(Iivari et al., 1998; Burrell & Morgan, 1979; Kling & Scacchi, 1982)
<b>System</b>	“a group of interrelated components that function together to achieve a desired result”	E.g. – “MHealth” comprising internet, mobile phone, pedometer, weighing scale, etc. Systematic arrangement of mutual interaction	(Orlikowski & Robey 1991; Walsham; 1993; Iacono & Kling, 1988)

- MHealth characteristic: technology system; people; data and communication; context

The researcher aggregated the characteristics of the MHealth subcomponents to four categories. Thus, the inequalities in MHealth are the measures of differences in the MHealth-IS characteristics grouped within the four broad categories. Therefore, several sub MHealth elements that fell within these identifiable categories were inspected for coding. The researcher

used these MHealth categories reflectively, as coding templates to interrogate, analyse or cross-examine the PAB data. The categories are outlined as MHealth IS subcomponents, thus:

- The Technology System
- The People
- The Interactive Process (involving information and communication)
- The Context of MHealth

### 3.8.3.9. Open Codes assigned to their concepts

The researcher reflected on the MHealth characteristics to assign codes to concepts in a comparison that reflected a true meaning of the MHealth phenomenon. Sample of the concept to code insight is represented in Table 3.19.

**Table 3.19 Table of codes assigned to concepts**

How codes are assigned to concepts	
Code	Concept
<b>need for MHealth because of sedentary health risk</b>	participant developed interest in MHealth because it provides information of his health
<b>need for MHealth because it helped to improve self-care</b>	participants needed MHealth because it helped to improve self-care
<b>ownership of equipment for MHealth access</b>	need for ownership of equipment for MHealth access
<b>ownership of equipment for MHealth access</b>	need for ownership of equipment as a requirement for MHealth implementation
<b>creating MHealth awareness</b>	the need to create MHealth awareness
<b>knowledge that MHealth creates awareness of health status</b>	the need to create MHealth awareness of the benefits of MHealth

### 3.8.3.10. Codes of concepts represent inequalities or “measures of differences”.

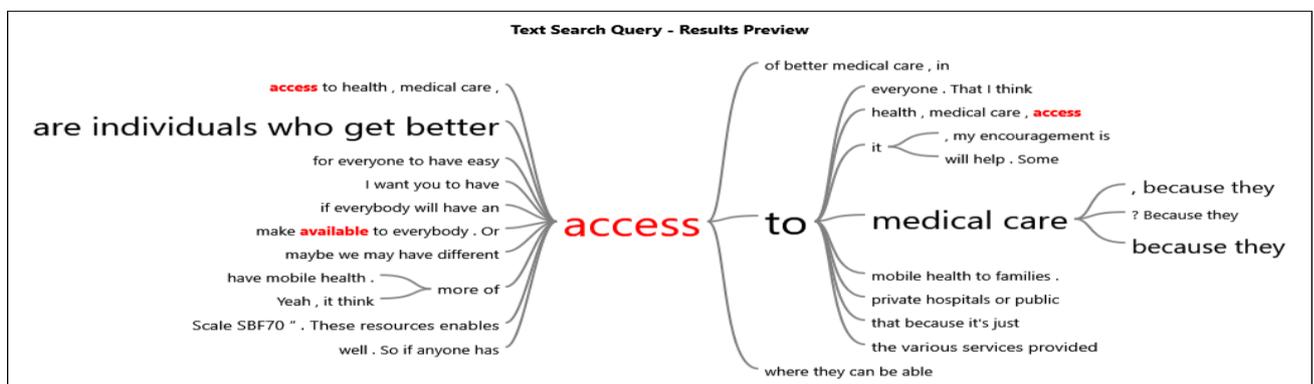
During the coding process the researcher began to realise that the PAB data represented the conceptualization of the measures of differences of the MHealth sub elements. Therefore, the outcome of the open coding identified the measures of differences in the MHealth characteristics indicated by the PAB data. The data pointed towards “measures of differences in the MHealth-IS” characteristics in terms of technology system, people, information, and

communication processes, and other subcomponents which continued to materialise as coding templates for interrogating, analysing or cross-examining the PAB data.

### 3.8.3.11. Concepts further assigned to their commonalities and to category

The researcher’s discovery that the codes were reflective of the MHealth characteristics and further highlighted the dimensional ranges or contrasts due to the differences that result to inequalities. As part of confirmation process, the researcher conducted a word-tree search on NVIVO with the various codes which emerged from the conceptualization. Figure 3.20 represents a word-tree search on the PAB data, by using NVIVO-12 software, for the word “access”. The word-tree in Figure 3.20 derive from a text search query for “access” conducted on the transcript of interview by using the Data Analysis Software, NVivo

**Table 3.20 Word tree: Access – word search from NVivo QDAS**



The text search in Figure 3.20 revealed some of the dichotomous concepts that describe individual differences of “access to MHealth”. The researcher believes that this descriptive outcome reinforces the dimensional contrast or differential range that describe the participant’s experiences of unequal access to MHealth.

The researcher organised these differential factors according to their commonality to form category, reflective of the MHealth characteristics: “the technology system; the people; the interactive process; and the MHealth context”. The organisation of the open codes in their commonality formed new categories.

**Table 3.21 From concept to open codes, and context to commonality, to category**

Open Code (concept or theme)	the Context	Commonality	Category
			MHEALTH SYSTEM INEQUALITY
); 1.1.3 availability and cost of mHe	<b>Consumer Access to mHealth</b>	MHEALTH SYSTEM INEQUALITY was predicted by Consumer Access to mHealth	
internet connection	internet connection is a requirement to access mHealth	consumer access to mHealth was predicted by access to internet connection	<b>consumer Access to mHealth</b>
ownership of digital devices such as Smartphone, weighing scale, activity sensor	ownership of digital devices such as Smartphone, weighing scale, activity sensor for access to mHealth	consumer access to mHealth was predicted by ownership of digital devices such as	

The open codes share common characteristics or commonalities which the researcher used to subsume the open codes into various categories. The categories result to different factors, representing the differences due to, technology access, suitability of technology/equipment, and autonomy of technology/equipment. Table 3.22 represents an example of the property range and dimensional contrasts that give rise to the categories.

**Table 3.22 Property range and dimensional contrast that defines the Categories**

Examples of property range and dimensional contrast that define the categories				
Property range			Dimensional Contrast	Category
No need of MHealth	- - -	Have need for MHealth	Unavailable - Available	<b>Access to technology</b>
Not aware of MHealth	- - -	Have awareness of MHealth		
No MHealth hardware	- - -	Have MHealth Hardware		
No MHealth Software	- - -	Have MHealth Software		
No Internet connection	- - -	Have Internet connection		
Inferior hardware	- - -	Superior Hardware	Unsuitable - Suitable	<b>Suitability of technology/ Equipment</b>
Inferior Software	- - -	Superior Software		
Old version	- - -	New Version		
Legacy System	- - -	Standard System		
Intra-operable system	- - -	Interoperable system		
Dysfunctional network	- - -	Functional Network		

Not easy to use	---	Easy to use		
Not feasible	---	Feasible		
Not effective	---	effective		
Centralised Control	---	Decentralised Control	Restricted/Control - Unrestricted	<b>Autonomy of technology</b>
Inflexible Resources	---	Flexible Resources		
Limited Time	---	Unlimited Time		
Limited internet	---	Unlimited Internet		
Regulated use	---	Unregulated use		

Following distinctions, codes are contextualised according to commonality and assigned category (Table 3.23).

**Table 3.23 How codes are contextualised to categories**

Codes are contextualised for commonality and assigned a category		
<b>Concepts are organised according to their commonalities so that categories of a higher order emerge</b>		
Concept/codes contextualized	Commonality (Common properties)	Category
<ul style="list-style-type: none"> <li>• <b>participant developed interest in MHealth because it provides information of his health</b></li> <li>• <b>need for ownership of equipment for MHealth access</b></li> <li>• <b>the need to create MHealth awareness</b></li> </ul>	<ul style="list-style-type: none"> <li>• access to MHealth will provide health information</li> <li>• access to MHealth requires equipment ownership</li> <li>• access to MHealth requires awareness</li> </ul>	Access to MHealth

After PAB data collection, the data analysis started with open coding posited by Corbin and Strauss (1990). Open coding conceptualised PAB data into concepts and further into open codes (Corbin & Strauss, 1990). The open codes were contextualised according to their commonality and assigned a category. The categories are the antecedents of inequalities in consumer MHealth identified in the list and shown in the illustration of the open coding process (Figure 3.11). The antecedents (Figure 3.11) include:

1. Access, 2. Suitability, 3. Autonomy,
4. Perceived Benefits, 5. Perceived Constraints, 6. Demographic Factors,
7. Advocacy, 8. Social Network, 9. Social Support.

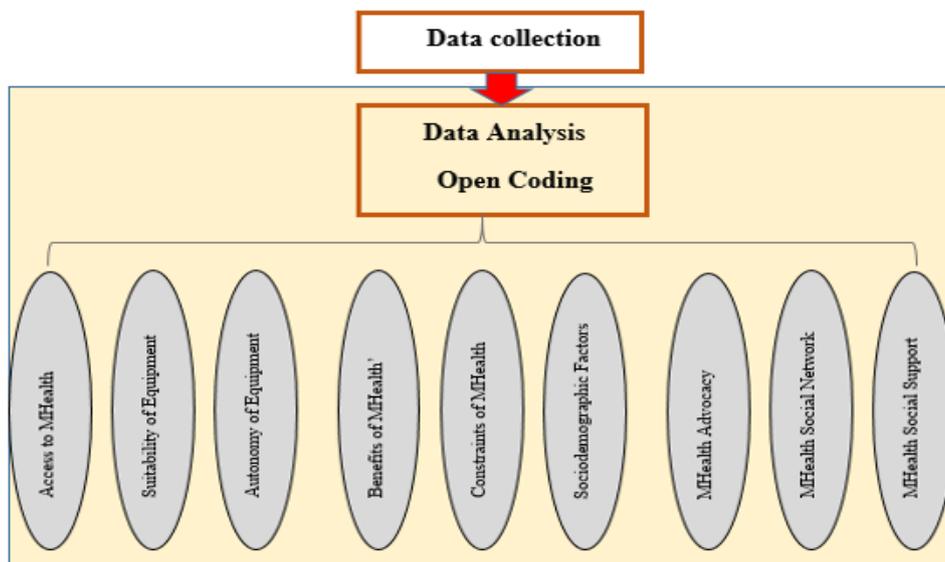


Figure 3.11 Nine antecedents developed from the open coding process

Extracts of the open coding (Tables 3.24; Table 3.25) shows the coding process from PAB data to concept, to open code, and to commonality, emerging into category.

Table 3.24 Extract A: Open codes, commonality, to category (Appendix K)

		MHEALTH PAB INEQUALITIES	MHealth differences that impact PAB
		SAMPLE OPEN CODING USED DURING DATA ANALYSIS	
		INTERVIEW TRANSCRIPT, TAP AND RPP INCIDENT REPORTS	Open Codes
1.0) SYSTEM INEQUALITY	a measure of differences or level:		
1.1 User Access to	was predicted by	1.1.1 availability and cost of internet connection; 1.1.2 availability and cost of mHealth digital devices (Smartphone, W	
	Q7.0	What do you recall as key problems, challenges or concerns with the usage of the app or Similar health innovation technologies?	
1.1.1	user connection to internet	08. CORK 4.2 So I think once you have internet you're able to use it	user connection to internet
	TAP	TAP AND RPP INCIDENT REPORT	
1.1.2	user ownership of digital devices such as Smartphone, weighing Step 60	23. DUBLIN 12.1 Ownership of Smartphone and internet connection were prerequisites	user ownership of digital devices such as Smartphone.
		Healthcoach app description	
1.1.3	user access to mHealth software	01. CORK 1.1 INCIDENT REPORT Whether you are on holiday, business trip or at the doctor, the application allows you to always	user access to mHealth software
	Q5.1	Do these obstacles still exist for you to use mHealth?	
	user affordability of mHealth	21 DUBLIN 11.1 Yes, such obstacles still exist because if something, its just like the health people telling us to go in the direction of eating healthy, but when you go to the supermarket, most of the things that are supposed to be healthy things are the most expensive. So they are not very cheap for people to access. So if things are made easier for people like commoners like us, to be able to get through to them. Of course lots of people will jump at it.	user affordability of mHealth
	Q6.1	How seriously, would you take this app if it was approved by the National Health Service Provider to serve as your health coach guiding you encourage Virgin and supporting you.	
	user affordability of mHealth	08. CORK 4.2 I would use it. I would probably buy it if I could afford it, but I'd use. Yes, I would definitely buy it if it was beneficial because it's set to be, you know, really good for you. But the only problem is I, I probably wouldn't be the same. I might not use it as much just because I think it's like a little bit more expensive and a lot of people mv. are probably don't. I don't know. have the	user affordability of mHealth

**Table 3.25 Extract B: Open codes, commonality, to category; see appendix L**

<p>MHEALTH PAT INEQUALITIES</p> <p>SAMPLE OPEN CODING USED DURING DATA ANALYSIS</p> <p>INTERVIEW TRANSCRIPT, TAP AND RPP INCIDENT REPORTS</p>	<p>MHealth differences that impact PAB</p>		
	Open Codes	Concept/proposal	Commonality
<p>1.1.1 availability and cost of internet connection; 1.1.2 availability and cost of mHealth digital devices (Smartphone, Weighing scale, Activity sensor); 1.1.3 availability and</p>			
<p>What do you recall as key problems, challenges or concerns with the usage of the app or Similar health innovation technologies?</p>			
<p>ou have internet you're able to use it</p>	<p>user connection to internet</p>	<p>user access to mHealth was predicted by user</p>	<p>user access to mHealth requires user internet connection</p>
<p><b>INCIDENT REPORT</b> 1 artphone and internet connection were prerequisites</p>	<p>user ownership of digital devices such as Smartphone,</p>	<p>user access to mHealth was predicted by user</p>	<p>user access to mHealth requires user ownership of digital devices such as</p>
<p><b>description</b></p>			
<p><b>01. CORK 1.1 INCIDENT REPORT</b> Whether you are on holiday, business trip or at the doctor, the application allows you to always</p>	<p>user access to mHealth software</p>	<p>user access to mHealth was predicted by user</p>	<p>user access to mHealth requires access to mHealth software</p>
<p>s still exist for you to use mHealth?</p>			
<p>21 DUBLIN 11.1 Yes, such obstacles still exist because if something, its just like the health people telling us to go in the direction of eating healthy, but when you go to the supermarket, most of the things that are supposed to be healthy things are the most expensive. So they are not very cheap for people to access. So if things are made easier for people like commoners like us, to be able to get through to them. Of course lots of people will jump at it.</p>	<p>user affordability of mHealth</p>	<p>user access to mHealth was predicted by the cost of mHealth</p>	<p>user access to mHealth requires to be affordable</p>
<p>How seriously, would you take this app if it was approved by the National Health Service Provider to serve as your health coach guiding you encourage Virgin and supporting you.</p>			
<p><b>08. CORK 4.2</b> I would use it. I would probably buy it if I could afford it, but I'd use. Yes, I would definitely buy it if it was beneficial because it's set to be, you know, really good for you. But the only problem is I, I probably wouldn't be the same. I might not use it as much just because I think it's like a little bit more expensive and a lot of people my age probably don't. I don't know. have the</p>	<p>user affordability of mHealth</p>	<p>user access to mHealth was predicted by the user affordability of mHealth</p>	<p>user access to mHealth requires to be affordable</p>

### 3.8.4. Grounded Theory: Axial Coding – Relationships between concepts

According to , axial coding is the second of the three phases of the coding process (Strauss & Corbin, 1990). Axial coding integrates the various categories derived during open coding into core categories by merging similar categories under fewer higher-level headings or axis. In the process of axial coding, the open coding categories are subsumed into few core categories which systematically emerge in a new level of data abstraction . It is pointed out that “the purpose of axial coding is to begin the process of reassembling data that were fractured during open coding”, back together, but in a novel way which provides greater explanatory power

(Strauss & Corbin, 1990, p. 97). Again, recommend that researchers should try to create an understanding of a phenomenon by association with time and place of events .

3.8.4.1. A coding paradigm of interactions and context, integrate structures to processes  
Straus & Corbin (1998) uses what they identified as “conditional structures” and “processes” which, they say are inextricably linked to capture the dynamics and complexities of how events occur . Straus & Corbin posits that “conditional structures” explicate questions about who, where, when, why, what, which, how, to uncover details of relationships . The details of relationships provide a means to relate structural conditions to process in which the phenomenon occur . Similarly, “process” denotes the action/interaction over time, of people or organizations in response to certain problems and issues . Straus & Corbin suggest that combining conditional structure (why) with process (how) are inextricably linked to capture the dynamic complexity that explain why and how events occur .

3.8.4.2. Axial coding paradigm of “actions, interactions and consequences” involving conditions, context, and strategies

Data analysts suggest that linkages among categories (based on why, when, and where) may be explicit or implicitly buried in data. Corbin and Strauss (1990) devised a helpful scheme of using framework to organise the emerging connections among categories . Corbin and Strauss (1990) also recommend that the use of a coding paradigm may also derive from researcher’s memos, and diagrams, illustrations, and field notes. The categories are related to core category through coding paradigm “of actions, interactions and consequences” involving conditions, context, and strategies (Corbin & Strauss, 1990). The coding paradigm forms an analytic tool which is devised by the researcher to systematically organise data in ways that integrate structure and process .

3.8.4.3. Precaution that coding framework may negate the grounded theory process

Some researchers have criticised the use of a coding paradigm recommended by Corbin and Strauss (1990), which according to the critics seems somewhat woolly and abstract. These critics say that the use of coding paradigm suggest “an intervention process that imposes rather than derives from data” . Glaser suggests that the use of paradigm negates rather than facilitates the concept and process of grounded theory by forcing the data into premature conceptual description instead of permitting emergence and discovery from data (Walker & Myrick, 2006).

The coding paradigm distinguishes approach from which follows a traditional rigorous positivists' perspective. uses qualitative analysis which has emphasis on objectivity, external reality, as well as neutrality of observer (Moghaddam, 2006). In comparison, uses qualitative analysis which tries to maintain a pragmatic approach with unbiased stance in data collection, also allows procedures that represent participant's view of their world (Moghaddam, 2006; Strauss & Corbin, 1990). However, qualitative data analysis literature, maintains that despite the differences, both procedures meet the rigorous requirements of a good scientific research, and are similar with respect to the main processes, of "categorising and constant comparison to produce theory grounded in data" (Moghaddam, 2006).

#### 3.8.4.4. Applying a coding paradigm to develop core categories

As per grounded theory procedure, axial coding involves the tasks of further developing categories, by connecting categories in terms of a sequence of relationships, and validating relationships. Grounded theory uses "paradigms", to focus on three aspects of the category to boost explanatory power. Thus, refers to: structures (causal conditions or situations) which lead to occurrence of a phenomenon (or category); the specific actions or interactions (or strategies) of the people in response to the situation; and, the consequences or outcome of the inaction or action taken (Walker & Myrick, 2006). Precisely, the approach recommends that the researcher examines the data for conditions, and interaction among the actors, as well as strategies, tactics, and consequences (Corbin & Strauss, 1990).

Applying the coding paradigm involves thinking about relationships between concepts, codes, and categories derived from the data. For a relationship, the researcher emulated a process of integration or a reversal of the disintegration process which already occurred during open coding. Previous examples of researchers applying the coding paradigm involves integration approaches that allows some flexibility (Spradley, 1979; Urquhart, 2001, pp. 8,9). To apply the Corbin and Strauss (1990) coding paradigm to this study, the researcher devised a method of relationship building with a "mapping framework" (See Table 3.26). The mapping framework in Table 3.26 is an integration table that brings together, the categories with the MHealth characteristics, as well as the axial coding factors. The researcher applied the coding framework table by mapping the categories in two directions: 1. to their equivalent MHealth characteristics, and 2. by also aligning the categories to their corresponding axial coding paradigm (structure, interaction, or outcome). The coding framework alignment resulted to new organisation of categories which provided insight into core categories. The axial coding paradigm was further contextualised within the MHealth characteristics or subcomponents.

The researcher recognised that the established relationships are also reflective of the MHealth phenomenon during the data collection phases. The researcher's notes and reports of direct observation of the TAP/RPD protocols during the data collection identifies the three stages of MHealth: at pre-implementation, and the implementation, as well as the usage period . The relationships established through the mapping framework is reflective of the structures and processes at pre-implementation, implementation, and usage period of MHealth. The mapping framework for the integration process is illustrated in Table 3.26.

#### 3.8.4.5. Coding framework: subsume the categories into few core-categories

Glaser (1978) identified the core category as a dimension of the research problem which derives from the process. Referring to the axial coding framework in Table 3.26 the MHealth-IS phenomenon provides a template or model to distinguish and contextualise the categories into core categories. Coding literature indicates that the categories are related to core category through coding paradigm by connecting to “actions, interactions and consequences” and involving conditions, context, and strategies (Corbin & Strauss, 1990). Again, the sub elements of an information system have relevance in the integration process of axial coding. Information system (IS) is “as an arrangement of people, data, processes, and information technology (IT) that interact to collect, process, store and provide as output the information needed to support an organisation” . Information technology (IT) describes the combination of computer technology (hardware and software) with telecommunication technology (data, image, and voice networks). Therefore, axial coding as an aspect of “analysis” involves reassembling the phenomenon into relationships . The reassembly process helps to interconnect the categories and the various aspects of MHealth phenomenon which helps to point to the corresponding core category . This process is illustrated in Table 3.26 where the categories are mapped to the MHealth-IS elements, and to the structures, interaction or outcome of the paradigm which points to the corresponding core category.

An insight is relevant here which shows that data analysis and differentiation have something in common with coding . Also, we take account of inequalities in consumer MHealth as the outcome of “differences” associated with the MHealth subcomponents . Thus, inequalities in MHealth-IS can be determined in the differences relating to the following factors, thus:

- systematic differences in people, data, processes, IT : where IT comprise of IT Hardware, IT Software, Data, Information, Networks
- systematic differences in the process (capture, process, store, and provide information)

- systematic differences in Information and communication
- systematic differences in contextual/environmental support

Therefore, the researcher examined inequalities in MHealth as measures of differences in the MHealth by using IS characteristics of the following factors:

- technology system
- people/IS stakeholders
- processes of information and communication
- context/environment

Thus, these aggregated groups of MHealth subcomponents are arranged and used as a template to analyse the categories into core categories. Thus, the re-integration process allowed the combination of the categories to merge under few core categories with some level of abstraction from the data. The outcome of this process is the organisation of the categories under three core categories represented by “MHealth system; MHealth utilisation; and MHealth communication”. Again, the axial coding paradigm is illustrated in Table 3.26.

Table 3.26 Mapping framework- subsumes the categories into core categories

Axial coding framework- subsuming the "Categories into few Core-Categories"										
Categories	"IS" defined as systematic arrangement of people, data, IT, processes that interact to provide information- in a social and environmental context					Axial Coding Paradigm, Strauss & Corbin (1998)			Perceived mHealth Service In/equality	
	people	data	process	IT	information	organisation	Structure	interaction	outcome	Core-Categories corroboration from memo
Access to Resources				x			x			mHealth System
Suitability of Equipments				x			x			mHealth System
Autonomy of Resources				x			x			mHealth System
Perceived Benefits of mHealth					x				x	mHealth Utilisation
Perceived Constraints of mHealth					x				x	mHealth Utilisation
Socioeconomic & demographic Factors					x				x	mHealth Utilisation
MHealth Advocacy					x			x		mHealth Communication
Social Network	x							x		mHealth Communication
Social Support						x		x		mHealth Communication

*\*Core-category is corroborated with researcher's memo of pre-implementation, implementation and usage of mHealth during "TAP/RPD" data collection*

The categories (Table 3.26) are grouped to form core categories by corroborating the data collection journey, through MHealth pre-implementation and implementation, as well as the period of use of MHealth as documented in the TAP/RPD report. During data collection, the pre-implementation of MHealth focused on the readiness of PAB individuals for access to the MHealth system. At the implementation phase, the presence of basic MHealth requirements were confirmed, and additional equipment was provided to the PAB participant to establish connection or access to the MHealth system. At the implementation phase, the MHealth activity was marked by interaction and communication between the PAB participant and researcher. The interactive communication covered the period of implementation with the TAP installation protocol, and up to the RPD and in-depth interviews. Finally, during the usage experience demonstration with the RPD the focus was on the utilisation of the MHealth. The questions about utilisation were focused on how PAB participants used MHealth and why or why not. Therefore, the period of data collection, at pre-implementation was reflective of a readiness or preparedness for MHealth PAF, indicative of concerns for access. The period of the installation stage was marked by interaction, information sharing and communication. The usage period was reflective of utilisation of the MHealth service. The data collection period and the TAP/RPD protocols corroborated with the integration of categories. The three phases of MHealth correspond to the following categories:

- pre-implementation of MHealth PAF focused on preparedness for MHealth access
- implementation of MHealth PAF focused on information sharing and communication
- usage period of MHealth PAF focused on utilisation by PAB participants

As illustrated in Table 3.27, the three periods of pre-implementation, implementation and usage periods correspond to the MHealth categories identified.

#### 3.8.4.6. MHealth Information Systems Core-categories

Table 3.27 represents how categories are mapped through the MHealth characteristics, as well as the axial coding paradigm factors which resulted to the various core categories. The emergent core categories are System access, Information utilisation, and interactive communication. The core categories of the mapping framework corroborates the data collection phases, and reflects the information systems' analysis espoused by Iivari, et al (Iivari et al., 1998). Figure 3.12 represents an illustration of categories (antecedents) and the core categories (intermediate factors) developed through the axial coding.

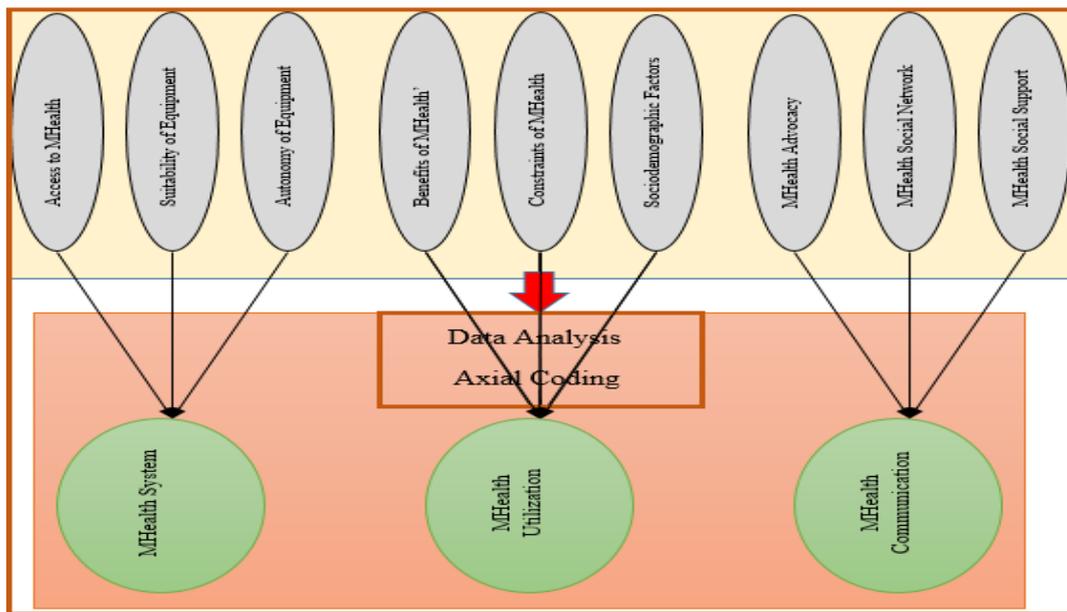


Figure 3.12 Illustration of intermediate constructs are the outcome of axial coding

3.8.4.7. Core category: MHealth systems

From the axial coding framework, three categories (antecedents) were subsumed into one core category (intermediate factor). For example MHealth access, suitability of equipment, and autonomy of equipment were subsumed into MHealth system. Table 3.28 illustrates the three categories and their emergence onto MHealth system in the coding framework.

Table 3.27 Axial coding framework: mapped category to core category - MHealth system

Axial coding framework- subsuming the "Categories into few Core-Categories"										
Categories	"IS" defined as systematic arrangement of people, data, IT, processes that interact to provide information- in a social and environmental context						Axial Coding Paradigm, Strauss & Corbin (1998)			Perceived mHealth Service In/equality  Core Categories corroboration from memo
	people	data	process	IT	information	organisation	Structure	interaction	outcome	
Access to Resources				x			x			mHealth System
Suitability of Equipments				x			x			mHealth System
Autonomy of Resources				x			x			mHealth System

Consequently, MHealth access, MHealth suitability and MHealth autonomy are subsumed into the MHealth system as a focal factor. Figure 3.13 illustrates the path diagram and how the categories merge onto the core category (MHealth system).

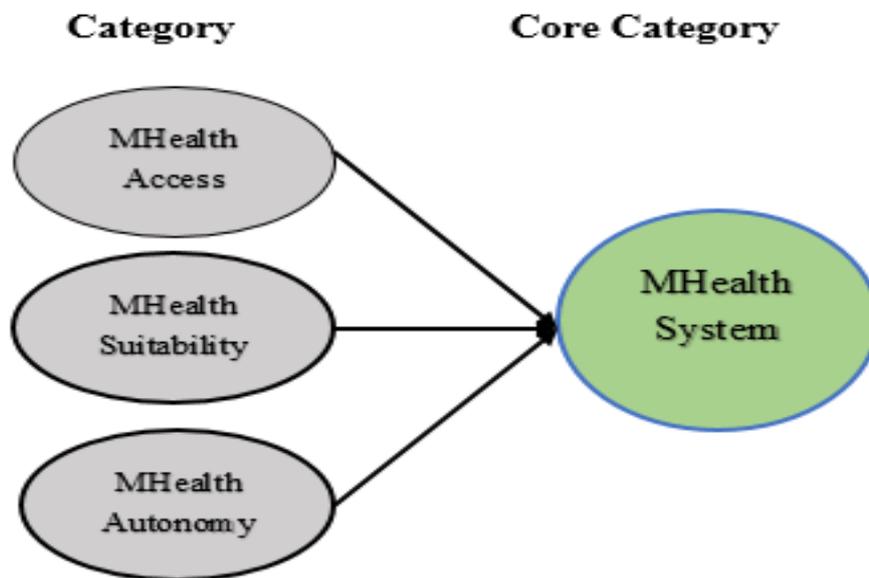


Figure 3.13 Three categories mapped to MHealth system (core category)

3.8.4.8. Core category: MHealth utilisation

The next three categories in the axial coding paradigm comprise of “perceived benefits, perceived constraints, and socioeconomic and demographic factors” which are subsumed onto MHealth utilisation as their focal factor. Table 3.28 illustrates the three categories and their emergence onto MHealth utilisation in the coding framework.

Table 3.28 Axial coding: category is mapped to core category for MHealth utilisation

Axial coding framework- subsuming the "Categories into few Core-Categories"										
Categories	"IS" defined as systematic arrangement of people, data, IT, processes that interact to provide information- in a social and environmental context						Axial Coding Paradigm, Strauss & Corbin (1998)			Perceived mHealth Service In/equality Core Categories corroboration from memo
	people	data	process	IT	information	organisation	Structure	interaction	outcome	
Perceived Benefits of mHealth					x				x	mHealth Utilisation
Perceived Constraints of mHealth					x				x	mHealth Utilisation
Socioeconomic & demographics					x		x			mHealth Utilisation

Consequently, “perceived benefits, perceived constraints, and socioeconomic and demographic factors” are subsumed onto the MHealth utilisation. Figure 3.14 illustrates the path diagram and how the categories merge onto the core category (MHealth utilisation).

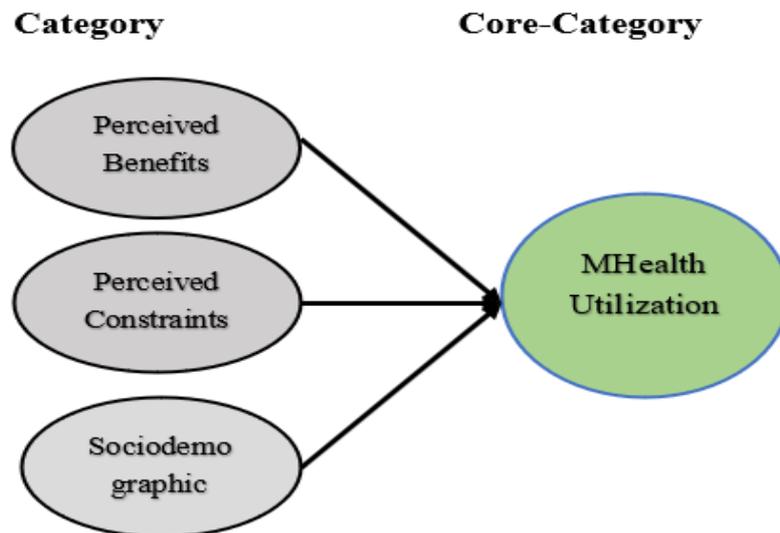


Figure 3. 14 Three categories mapped to MHealth Utilisation (core category)

3.8.4.9. Core category: MHealth Communication

The last three categories in the axial coding paradigm comprise of “advocacy, social network, and social support” which are subsumed onto MHealth communication as their focal factor. Table 3.29 illustrates the three categories and their emergence onto MHealth communication in the coding framework.

Table 3.29 Axial coding: category is mapped to core category - MHealth communication

Axial coding framework- subsuming the "Categories into few Core-Categories"										
Categories	"IS" defined as systematic arrangement of people, data, IT, processes that interact to provide information- in a social and environmental context						Axial Coding Paradigm, Strauss & Corbin (1998)			Perceived mHealth Service In/equality
	people	data	process	IT	information	organisation	Structure	interaction	outcome	Core Categories corroboration from memo
MHealth Advocacy					x			x		mHealth Communication
Social Network						x		x		mHealth Communication
Social Support						x		x		mHealth Communication

Consequently, “perceived benefits, perceived constraints, and socioeconomic and demographic factors” are subsumed onto the MHealth utilisation. Figure 3.15 illustrates the path diagram and how the categories merge onto the core category (MHealth utilisation).

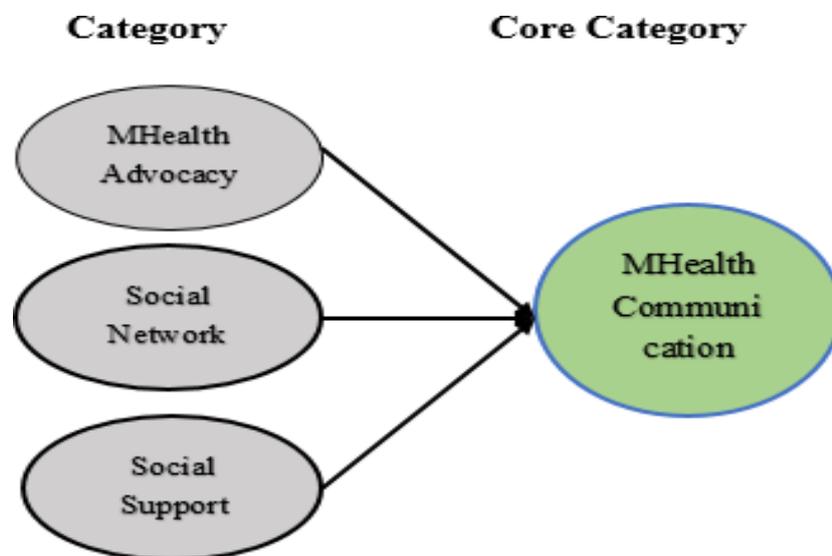


Figure 3.15 Three categories mapped to MHealth communication (core category)

### 3.8.5. Grounded Theory: Grounded theory: Selective Coding

The third and final phase of the process is selective coding. Selective coding is the coding around the core categories. The aim of selective coding is to integrate the core categories under a single theme, usually the phenomenon which forms the theoretical framework when it connects. suggest that several approaches can be applied to facilitate the integration process which may involve following a storyline, the researcher’s diagrams or notes that reflect the events of the phenomenon. Selective coding procedure involves the process of regrouping the core categories under a single theme that describes the “what and why” of the phenomenon, in this case, how inequalities in MHealth occur.

Given the exploratory nature of this research, the interrelationship between the core-categories and the MHealth phenomenon provide a reasonable proposition for the antecedents of inequalities in consumer MHealth. In this study, selective coding finally builds the story that forms a more precise explanation of inequalities in MHealth . Writing about “explanation”, opined that researchers try to create understanding of a phenomenon by using “time and place” to explain . The aim of “explanatory schemes are to create understanding, guide behaviour and

provide power for scientific prediction, as well as to control events . provides an analogy how “an explanation... tells a story”. The story telling analogy, is that “explaining” tells a story about the relations among things, among people and events . According to analogy, “explaining”, in a complex story designates objects, events, to state or imply the dimensions and properties. Other researchers agree that, “explanatory stories” provide some context, indicate conditions for whatever action or interaction of the central event, and sometimes imply one or more consequences as a conclusion (Schatzman, 1991).

#### 3.8.5.1. Reassembling the sub elements of the MHealth phenomenon

Drawing insight from Corbin and Strauss (1990) analogy, this study is also a story about inequalities in consumer MHealth innovation . The story of this research is weaved around the consumer MHealth information system (IS) described as an arrangement of people, data, processes, and mobile information technology that interact to collect, process, store and provide as output the information needed to support healthcare . Also, information technology (IT) is described as a combination of computer technology (hardware and software) with telecommunication technology (data, image, video, and voice networks) . The coding process was reflective of the IS characteristics as a coding template for interrogating and cross-examining the PAB data, and to capture their descriptions of how the disparities were inextricably intertwined with what they know and think of MHealth, and how they felt, reacted, or behaved towards MHealth.

The selective coding is the continuing process of data integration which began in the axial coding . Selective coding is a continued integration by reassembling into relationships all the sub elements of MHealth phenomenon that were broken during the open coding phase of analysis .

#### 3.8.5.2. Explanation of the selective coding framework

Thus, inequalities in MHealth were defined as the outcome of the stakeholders’ interests and activities across the sociotechnical environment of the MHealth IS ecosystem (Iivari et al., 1998; McLeroy et al., 1988). Similarly, IS was defined as “a systematic arrangement of people, data, IT, processes that interact to provide information to support organisation” . Thus, the researcher aggregated inequalities in consumer MHealth within the following context: 1. MHealth IT system, 2. The people & context, 3. Information and interactive health communication. A framework table was organised to show how the core categories were inextricably corroborated with the three MHealth phases of the data collection process.

Furthermore, the core categories were inextricably intertwined with MHealth IS ecosystem. Again, the MHealth phases during data collection includes the pre-implementation focused on IT access, the implementation focused on interactive communication, and the usage phase focused on PAB utilisation of MHealth. Table 3.30 represent the three MHealth phases during data collection and their focus and target interest.

**Table 3.30 Corroborates core categories with three MHealth phases during data collection**

<b>Corroboration with the three mHealth phases of the data collection process</b>		
<b>Pre-implementation Focused on IT Access</b>	<b>Implementation focused on interactive Communication</b>	<b>Usage Phase focused on Utilization</b>
<b>[mHealth IT] System</b>	<b>[Process of] Health IT communication</b>	<b>[People's] Information Utilization</b>

The pre-implementation, the implementation, and the usage phase of MHealth with inequalities in MHealth comprising of MHealth IT systems, the people, and the context, as well as the interactive communication which defines the MHealth IS. Inequalities in MHealth is the outcome of the stakeholders' interests and activities across the sociotechnical environment of the MHealth IS ecosystem. Inequalities are embedded within, 1. MHealth IT system, 2. The people & context, 3. Information & interactive health communication. Table 3.31 is an illustration of inequalities in MHealth and the composites.

Table 3.31 MHealth Inequalities- people, IT systems, information, communication

<b>Inequalities in mHealth is the outcome of the stakeholders' interests and activities across the sociotechnical environment of the mHealth IS ecosystem. Inequalities are embedded within:</b> <b>1. mHealth IT system, 2. The people &amp; context, 3. Information &amp; interactive health communication</b>									
mHealth ecosystem of people and the context					mHealth IT System				
Regulatory and Policy	Organisation	Social	Individual	In/equalities in mHealth	Internet Connection	Health App	Smart Phone	Smart Scale	Activity Sensor
x	x		x	Access to mHealth	x	x	x	x	x
x	x		x	Equipment Suitability	x	x	x	x	x
x	x		x	Equipment Autonomy	x	x	x	x	x
	x	x	x	Perceived Benefits					
	x	x	x	Perceived Constraints					
x		x	x	Socio-demographic					
x	x	x		Advocacy					
	x	x		Social Network					
x	x	x		Social Support					

Table 3.32 MHealth inequalities are stakeholders' interests and activities in ecosystem

Inequalities in MHealth is the outcome of the stakeholders' interests and activities across the sociotechnical environment of the MHealth IS ecosystem. Inequalities are embedded within: 1. MHealth IT system, 2. The people & context, 3. Information & interactive health communication					Corroboration with the three MHealth phases of the data collection process							
MHealth ecosystem of people and the context					MHealth IT System					Pre-implementation Focused on IT Access	Implementation focused on interactive Communication	Usage Phase focused on Utilisation
Regulatory and Policy	Organisation	Social	Individual	In/equalities in MHealth	Internet Connection	Health App	Smart Phone	Smart Scale	Activity Sensor	[MHealth IT] System	[Process of] Health IT communication	[People's] Information Utilisation
x	x		x	Access to MHealth	x	x	x	x	X	o		
x	x		x	Equipment Suitability	x	x	x	x	X	o		
x	x		x	Equipment Autonomy	x	x	x	x	X	o		
	x	x	x	Perceived Benefits								o
	x	x	x	Perceived Constraints								o
x		x	x	Socio-demographic								o

x	x	x	Advocacy		0
		x	Social Network		0
x	x	x	Social Support		0

The selective coding (Table 3.32) shows how inequalities in an MHealth IS are inextricably intertwined across the MHealth system, the people and the context and the information and interactive communication. Furthermore, the inequalities in MHealth IS across the sub components are corroborated with the three MHealth phases of the data collection process. The selective coding process revealed how the categories, the core categories and the and the inequalities in MHealthare innovation are inestricably intertwined across the sociotechnical environment of the MHealth ecosyste. Figure 3.16 depicts the application of open coding, axial coding, and selective coding espoused of the grounded theory espoused by Strauss and Corbin (1990).

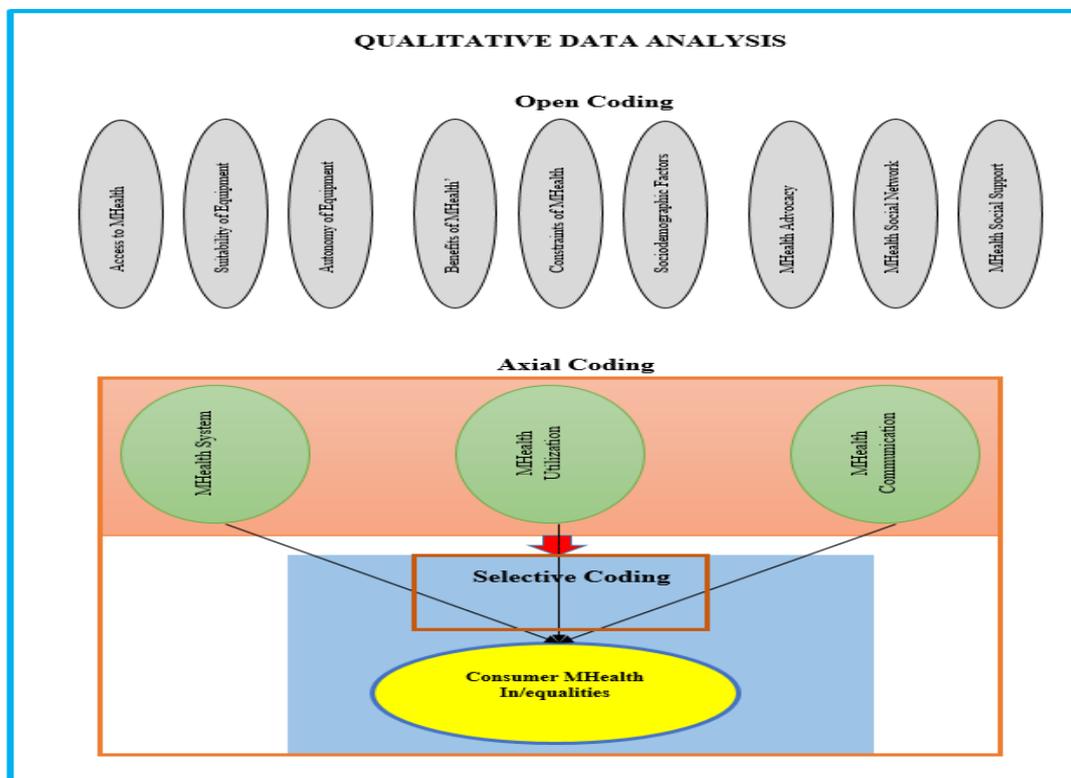


Figure 3.16 Sequence of Grounded Theory coding following Strauss and Corbin (1990)

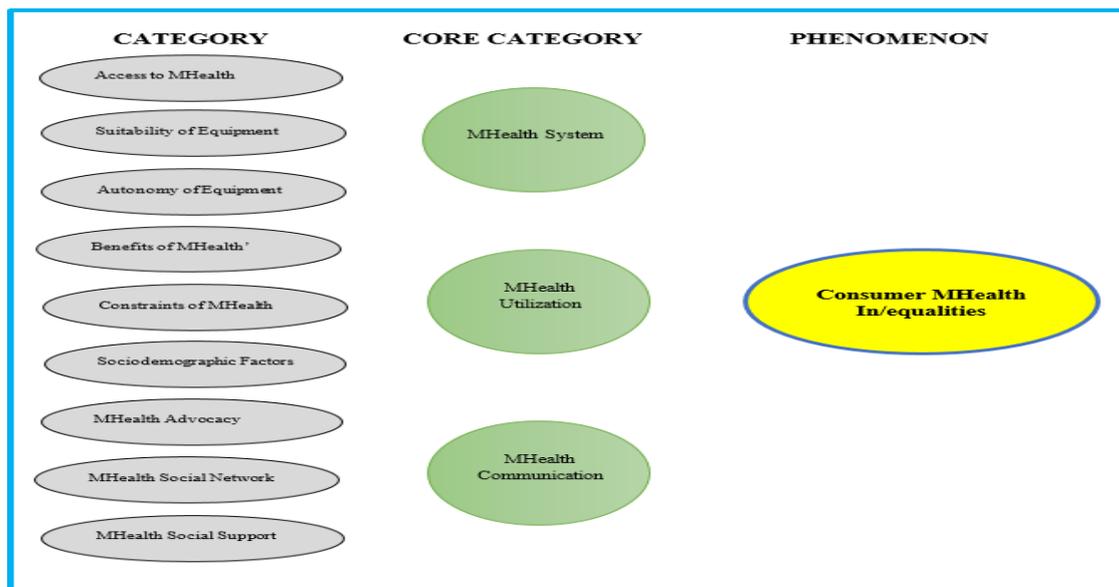
3.8.5.3. The antecedents and intermediate factors of inequalities in MHealth

The outcome of the open coding and axial coding is the discovery of the antecedents and the intermediate factors of inequalities in MHealth.

**Table 3.33 Categories and core categories of inequalities in consumer MHealth**

<b>Open coding for Antecedents (category)</b>	<b>Axial coding for Intermediate factors (core category)</b>	<b>Selective coding arrives to:</b>
<i>Access to MHealth</i> <i>Suitability of Equipment</i> <i>Autonomy of Equipment</i>	<b>In/equalities in MHealth Systems</b>	<b>Inequalities in MHealth</b>
<i>Perceived Benefits</i> <i>Perceived Constraints</i> <i>Socio-demographic factors</i>	<b>In/equalities in MHealth Utilisation</b>	<b>Inequalities in MHealth</b>
<i>Advocacy of MHealth</i> <i>Social Network</i> <i>Social Support</i>	<b>In/equalities in MHealth communication</b>	<b>Inequalities in MHealth</b>

3.8.5.4. Antecedents (category), and intermediate factors (core category) as formative factors of in/equalities in MHealth are shown in Figure 3.17



**Figure 3. 17 Category, core category and MHealth inequalities**

### **3.8.6. Robustness of naturalistic research and validation of qualitative analysis**

#### **3.8.6.1. Robustness of Naturalistic Research Methodology and qualitative data analysis**

Methodological concern is a source of debate in naturalistic studies that often involve gathering non-random samples to generate complex qualitative data, which also target holistic meaning (O'leary, 2004; Ritchie et al., 2013). The complexities in qualitative research data analysis arise from inherent constructive biases and negotiated interpretations between participants and researchers (Edge & Richards, 1998; O'leary, 2004). Furthermore, the emergent nature of qualitative methodology, with the inductive analysis and idiographic interpretations, give rise to credibility concerns for the research findings (Edge & Richards, 1998; O'leary, 2004).

#### **3.8.6.2. Robustness validation for qualitative methodology**

Validation is built into each research phase by following clearly defined methodological guidelines for research design, sampling, data collection, data analysis and report of finding. Grounded theory involves constantly comparing the products of analyses against actual data, making necessary modifications and revalidating continually (Bitsch, 2005; Robert Yin, 1984).

The recommendation is that regardless of paradigmatic positioning, research studies, especially those which rely on qualitative data, need to address methodological concerns that may bias subjective interpretations or negatively impact broad applicability and verifiability of finding (Guba & Lincoln, 1994; O'leary, 2004). Research studies suggest that qualitative studies that delve deeper can establish research credibility by ensuring thoroughness (Cope, 2014; Decrop, 2004; Houghton et al., 2013; O'leary, 2004; Thomson, 2011).

## **3.9. Chapter Summary and Conclusion**

Chapter 3 presents the research philosophy and choice of methodology for this research. The research objective and the questions formulated in literature review was applied as the starting points for the methodology chapter. Based on the research objective, a suitable research paradigm was chosen which pointed to a naturalistic study for consumer MHealth investigation from which little was known.

The interpretivist research paradigm was deemed suitable for the inquiry. The investigation followed explorative case study using qualitative research approach. The qualitative methodology was followed to capture the complexity of real life, and in-depth accounts of

human sense making in sociotechnical inquiry for theory building in MHealth. Purposive quota sampling strategy was deemed suitable for selecting information-rich samples from the PAB population and to ensure that relevant categories of cases were represented within the sampling universe.

The field work was operationalised with the use of MHealth PAF which involved four stages of data collection. Day one of the field work involved demographic data collection as well as the MHealth installation using TAP for observational data. After MHealth installation, the PAB participants were allowed to use the MHealth PAF for a minimum of 8 weeks. After 8 weeks duration the researcher returned to the PAB participants for data collection which involved the use of RPD and in-depth interviews.

All collected data were anonymised and the interviews were transcribed verbatim, organised, and analysed using NVivo QDAS and grounded theory analysis. The grounded theory approach of data analysis was concurrently applied which resulted to categories and core categories of MHealth inequalities. The grounded theory method of analysis of the PAB data resulted to development of the antecedents and the intermediate factors of MHealth inequalities. Chapters 4, 5, and 6 addresses research questions 1, 2, and 3, by exploring the factors developed in the grounded theory analysis.

## **CHAPTER 4.**

### **ANTECEDENTS OF INEQUALITIES IN CONSUMER MHEALTH**

#### **4.1. Introduction**

Chapter 4 presents an outcome of the research analysis focusing on research question 1, addressing the antecedents of MHealth inequalities in consumer MHealth innovation for PAB. Section 4.2 restates the research question 1 and highlights the relevance of the question. Section 4.3 presents the antecedents of inequalities in consumer MHealth with the corresponding citation evidence. Section 4.4 presents The intermediate constructs are relationship factors (section 4.4) linking three antecedents together. Section 4.5 presents the chapter summary and conclusion on research question 1.

#### **4.2. Research Question 1**

**What are the Antecedents of Inequalities in Consumer MHealth Innovation for people of African background (PAB) in the Republic of Ireland (ROI)?**

##### **4.2.1. Relevance of the antecedents of MHealth inequalities**

The question about the antecedents of inequalities in consumer MHealth is designed to explore the formative factors of inequalities in consumer MHealth (Weiss & Eikemo, 2017). Discovery of the antecedents of inequalities in consumer MHealth is designed to address the foundational theoretical problems of the lack of important concepts and to reveal the composition of inequalities in the MHealth phenomenon. To conceptualize the antecedents of inequalities in consumer MHealth is to discover the important factors or constructs required for MHealth stakeholders to understand and explain the new ways by which MHealth innovation generate disadvantages that reinforce or aggravate health inequalities. Inequalities in MHealth will remain misunderstood and misapplied if the foundational theoretical problems of the lack of important concepts are not resolved. Discovery of the antecedents of inequalities in consumer MHealth helps to map out the conceptual landscape, and further decompose the formative factors into hierarchical orders for ease of understanding and application (Shahriar Akter et al.,

2013; Bagozzi & Yi, 2012; Kenny, 2016). Chapter 4 presents the antecedents of MHealth inequalities which are grounded in the analysis of the PAB data.

#### **4.2.2. The formative factors of inequalities in consumer MHealth**

The grounded theory analysis (chapter 3) developed nine antecedents and three intermediate factors (Figure 3.12) which impact inequalities in consumer MHealth. The antecedents are formative (first order) factors in the chain of events. The intermediate (second order) factors are relationship constructs. The antecedents directly impact the intermediate factors.

Therefore, the formative factors of inequalities in consumer MHealth comprise of nine antecedents, which are linked to three intermediate factors (Figure 3.12). Each intermediate factor derives from three antecedents (Figure 3.12). The findings also show the links between three antecedents to each intermediate factor. The findings show the following links:

Health System In/equalities derive from three antecedent variations (Table 3.27; Figure 3.13):

- in the level of access to MHealth
- in the level of suitability of MHealth equipment
- in the level of autonomy of MHealth equipment

MHealth Utilisation In/equalities derive from three antecedent variations (Table 3.28; Figure 3.14):

- in the level of perceived benefits of MHealth
- in the level of perceived constraints of MHealth
- in the demographic and socioeconomic factors

MHealth Communication In/equalities derive from three antecedent variations (Table 3.29; Figure 3.15):

- in the level of MHealth advocacy
- in the level of social network in MHealth
- in the level of social support in MHealth

Every antecedent factor is further discussed (section 4.3). The discussion in section 4.3 begins the validation process of all the factors. The aim of the validation is to certify the credibility of the constructs by tracing through the chain of evidence back to the source (collected data). A successful validation of the antecedent leads to a proposition.

### 4.3. The antecedents of inequalities in consumer MHealth

The grounded theory analysis derived nine antecedent factors which impact inequalities in consumer MHealth. The nine antecedents of inequalities in consumer MHealth are presented in the following list and defined in Table 4.1.

Inequalities in consumer MHealth are due to the variations in the levels of:

- access to MHealth
- suitability of MHealth equipment
- autonomy of MHealth equipment
- perceived benefits of MHealth
- perceived constraints of MHealth
- demographic and socioeconomic factors
- MHealth advocacy
- social network in MHealth
- social support in MHealth

**Table 4.1 Defines the antecedents which impact inequalities in MHealth**

<i>Antecedents of Consumer MHealth Inequalities</i>	<i>Definition</i>
<b>Access to MHealth</b>	Access to MHealth is defined as user awareness and interest in MHealth services in addition to the availability and ownership of essential MHealth resources (Erbes et al., 2014; Garner et al., 2018; Khatun et al., 2016; Khatun et al., 2015; Levesque et al., 2013).
<b>Suitability of MHealth Equipment</b>	Suitability of MHealth equipment is defined as the functional adequacy of MHealth equipment, or the appropriateness of the mobile devices and apps for the task (DiMaggio & Hargittai, 2001; Feinberg et al., 2017; Kim & Park, 2012; Vedanthan et al., 2015).
<b>Autonomy of MHealth Equipment</b>	Autonomy of MHealth equipment is defined by the level of user control of the MHealth equipment for physical activity and fitness (DiMaggio & Hargittai, 2001).
<b>Perceived Benefits (usefulness) of MHealth</b>	User perceived benefit or usefulness of MHealth was defined as the “degree to which a person believes that using an MHealth innovation would enhance his or her job performance” (Davis, 1989; Davis, Bagozzi, & Warshaw, 1989; Kim & Park, 2012).
<b>Perceived Constraints of MHealth</b>	User perceived constraints of MHealth is similarly refers to ease of use which is defined as ‘the degree to which using MHealth innovation is perceived as being difficult or otherwise easy to use (Moore & Benbasat, 1991; Venkatesh, Morris, Davis, & Davis, 2003).
<b>Socio-demographic Factors</b>	Characteristics of MHealth user (the PAB participants): Age, education, employment, income and location, were collected in the demographic survey
	MHealth advocacy is the strategic use of information to systematically promote MHealth, by targeting specific individuals and those with whom they live, and the larger social networks (community) to which individuals

<b>MHealth Advocacy</b>	are tied. (Chapman, 2004; Christoffel, 2000). MHealth advocacy during this research focused on the use of MHealth for physical activity and fitness (PAF) to enlighten PAB individuals and community (Health & Children, 2009; Macpherson, Purcell, & Bulley, 2009; McLeroy, Bibeau, Steckler, & Glanz, 1988; Tudor-Locke et al., 2011).
<b>Social Network in MHealth</b>	MHealth social network is defined as “the web of social media relationships” that surround specific individuals and those with whom they interact, and the larger community to which the individuals are linked (Christoffel, 2000; Glanz, Rimer, & Viswanath, 2008; Heaney & Israel, 2008).
<b>Social Support in MHealth</b>	Social support in MHealth is defined as the social influence, companionship, and support arising from ‘the web of social media relationships’ that surround specific individuals and those with whom they interact, and the larger community to which the individuals are linked (Christoffel, 2000; Glanz et al., 2008; Heaney & Israel, 2008).

### 4.3.1. Inequalities due to variations in the level of access to MHealth

The level of access to MHealth was derived as one of the antecedents of inequalities in consumer MHealth. Access to MHealth describes the “opportunity or ease with which consumers or communities are able to use appropriate MHealth services in proportion to their needs” (Levesque, Harris, & Russell, 2013). Access conceptualises the initial interaction in the use of MHealth services (Daniels, 1982; Levesque et al., 2013).

During the data collection process (chapter 3, MHealth installation with TAP), the technology was operationalised with consumer MHealth PAF. The installation also involved MHealth system elements such as internet connection, mobile health software app, smartphone device, the physical activity tracker, and the digital weighing scale, used during TAP and RPD (Appendix F). MHealth system describes a group of interrelated components that function together to achieve a desired result (Albahri, Zaidan, Albahri, Zaidan, & Alsalem, 2018; Hasselbring, 2000).

The variation in the level of access to MHealth impacts upon MHealth through the MHealth system. MHealth access is linked to user awareness as well as the users’ interest in MHealth services (Shahriar Akter & Ray, 2010b). The factors which influence initial access or initial contact with, or use of MHealth include the availability and ownership of MHealth resources, coupled with the awareness and interest in MHealth services (Garner et al., 2018; Khatun et al., 2015). MHealth user access therefore depends on availability and ownership of essential MHealth resources, and MHealth devices.

#### 4.3.1.1. Variations in the level of access to MHealth

Therefore, inequalities in consumer MHealth innovation are partly the result of the variations in the level of access to MHealth. Variation in access describes those who “have access”, and those who “have no access”.

Those with access and those without access are the result of the variations in:

- user awareness of MHealth services
- user interest in MHealth services, coupled with
- availability of MHealth resources
- ownership of the essential MHealth resources which include:
  - access to internet connection
  - access to Smartphone Device
  - access to mobile health software application (mobile health app)
  - access to MHealth devices: digital activity sensor; digital weighing scale.

The research findings from the PAB data reveals variations in access to MHealth in the form of dichotomous concepts that describe differences between two distinctive groups. The differences identify those who *have access*, and those who have no access to MHealth. Table 4.2 is an illustrative example of the dimensional contrast or differential range that describes the experience of unequal access to MHealth. The disparities between those who *have access*, and those who *have no access* are shown in Table 4.2.

**Table 4.2 Differential range in the table describes unequal access to MHealth**

Dimensional contrast or differential range that describe the experience of unequal access to MHealth				
Unequal MHealth access range			Dimensional Contrast	Category
No access to Internet connection	--	Access to internet connection	Unavailable - Available	<b>Unequal Access to MHealth</b>
Not access to smartphone device	--	Access to smartphone device		
No access to MHealth devices	--	Access to MHealth devices		
No access to mobile software app	--	Access to mobile software app		
No access to physical activity devices	--	Access to physical activity devices		

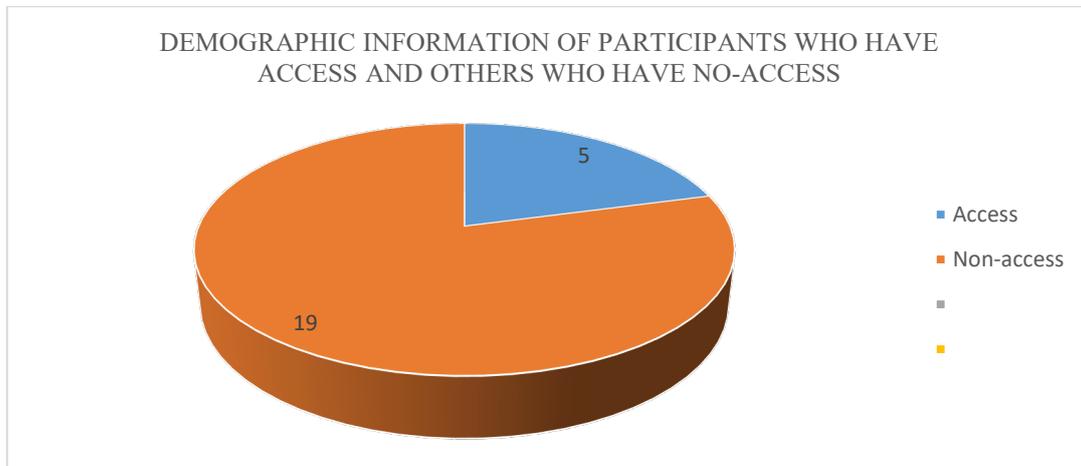
#### 4.3.1.2. Unequal access to MHealth for PAB participants

The demographic data analysis of PAB data (chapter 3) revealed that most PAB participants did not have access to MHealth (Table 4.3). The quantitative analysis of the survey data shows that 19 out of 24 PAB Participants have no access to MHealth during demographic survey, and before the MHealth installation.

As part of sampling process, the PAB information on MHealth awareness and ownership of MHealth resources were collected during the demographic survey in chapter 3. PAB Participants were deemed to have access to MHealth if they reported to have MHealth awareness, coupled with the ownership of the MHealth resources. The MHealth resources include, 1. Internet connection, 2. Smartphone, 3. Awareness of MHealth devices or app such as, 4. Digital Activity Tracker, 5. Mobile Health app and 6. Digital Weighing Scale. However, the data analysis shows that the main factor for lack of access for most PAB participants was linked to the lack of awareness of MHealth services, and no access to MHealth equipment .

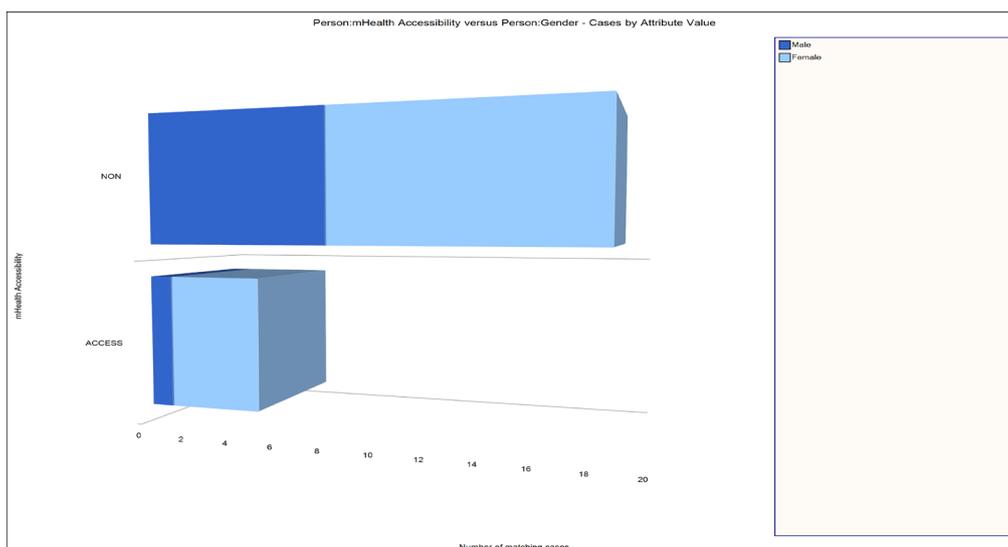
**Table 4.3 Demographic information of participants for access to MHealth**

<i>PAB Participants</i>	<i>Access to MHealth</i>	<i>Age</i>
01. CORK 1.1 J. E	NON	40 - 49
02. CORK 1.2 S. E	ACCESS	18 -19
03. CORK 2.1 C. D	NON	40 - 49
04. CORK 2.2 F. D	NON	40 - 49
05. CORK 3.1 T. E	NON	50 - 59
06. CORK 3.2 K. E	NON	50 - 59
07. CORK 4.1 D. U	ACCESS	18 -19
08. CORK 4.2 A. U	NON	20 - 29
09. GALWAY 5.1 J. U	NON	50 - 59
10. GALWAY 5.2 L. U	ACCESS	40 - 49
11. GALWAY 6.1 K. O	NON	60 - 65
12. GALWAY 6.2 G. O	NON	50 - 59
13. GALWAY 7.1 E. A	NON	50 - 59
14. GALWAY 7.2 E. A	NON	40 - 49
15. GALWAY 8.1 O. N	NON	40 - 49
16. GALWAY 8.2 L. N	NON	30 - 39
17. DUBLIN 9.1 P. G	NON	20 - 29
18. DUBLIN 9.2 E. G	NON	40 - 49
19. DUBLIN 10.1 C. F	NON	40 - 49
20. DUBLIN 10.2 A. F	ACCESS	40 - 49
21. DUBLIN 11.1 O. C	NON	40 - 49
22. DUBLIN 11.2 E. C	NON	40 - 49
23. DUBLIN 12.1 N. A	NON	40 - 49
24. DUBLIN 12.2 C. A	ACCESS	20 - 29
Participants with Access to MHealth	5 out of 24	
Participants with No Access	19 out of 24	



**Figure 4.1** Participants with access and those without MHealth access

The survey report shows that only 5 out of the 24 PAB participants had access to MHealth (owned internet connection and Smartphone, coupled with the awareness of MHealth device or apps). Also, 3 of the five PAB Participants with access to MHealth are below 30 years of age. Quantitative information including the age of the PAB participants with access to MHealth is a subject interest for quantitative research.



**Figure 4.2** Male and female PAB with MHealth access and those with no-access

#### 4.3.1.3. Citation evidence of the variation due to access or no access to MHealth

This research is anchored on multiple sources of information and coherent chain of evidence designed to avoid contradictions (Leppink, 2017; R Yin, 2014). Following is the chain of evidence shows that the level of access to MHealth impacts upon MHealth system inequalities.

It was noted during the demographic survey and the TAP that the ownership of smartphone and internet connection were prerequisites for participation in the research. In addition, PAB participants were given MHealth devices (physical activity tracker and digital weighing scale) to enable MHealth access. The citations for the access to MHealth are extracts of the evidence grounded in the data collected from PAB Participants. Citation evidence in Table 4.4 shows that the variation in the access to MHealth impacts upon MHealth system inequalities.

**Table 4.4 Variation due to access or no-access impact MHealth system inequalities**

P1- Variation due to access or no access to MHealth' impacts upon MHealth system inequalities.	
<i>Variation factor</i>	<i>Participant and the citation evidence</i>
Ownership of internet connection, a smartphone, mobile health software app, including physical activity tracker and a digital weighing scale were essential.	<b>Participant 23. DUBLIN 12.1:</b> <i>"Access to MHealth at the MHealth implementation phase of the research fundamentally required the internet connection, a smartphone, mobile health software app, including physical activity tracker and a digital weighing scale. The researcher ensured that these infrastructural elements were available to the participants at the MHealth implementation phase, during the TAP. Immediately after the demographic survey, the PAB participants were equipped with these basic requirements during the TAP for MHealth implementation. The details of the operationalisation of MHealth access, installation and usage involve the following: (i) Mobile phone, and (ii) Internet Connection, which were linked to (iii) Health app, (iv) Digital Activity Tracker, and (v) Digital Weighing Scale. This aspect of MHealth implementation also accounted for MHealth advocacy with the incentive of material and motivational support from the researcher to the participant"</i>
Level of Access to MHealth due to variations in Internet Connection, MHealth devices or Apps impacts MHealth System in/equalities.	<b>Participant: 02. CORK 1.2 SHANNON ERIC (TAP Report)</b> <i>"Details of the operationalisation of MHealth for installation, access and usage involve the following: (i) Access to Smartphone, and (ii) Access to Internet Connection, (iii) Access to Mobile health app (iv) Access to Digital Activity Tracker, and (v) Access to Digital Weighing Scale"</i>
Level of Access to MHealth due to variations in Internet Connection impacts MHealth System in/equalities.	<b>Participant 08. CORK 4.2:</b> <i>"...I think once you have internet, you're able to use it"</i>
Level of Access to MHealth due to free availability of MHealth resources impacts MHealth System in/equalities.	<b>Participant 21 DUBLIN 11.1</b> <i>"Well, I would say the first thing is this one came easy, it was free. Which means if health can be made accessible to people and made cheap enough it will encourage a lot of people to get into it. So, for me, I have never considered any app to be able to help me to improve my lifestyle until I came in touch with this. And because it was free, it didn't cost me anything"</i>
Level of Access to MHealth due to affordable cost of MHealth impacts MHealth System in/equalities.	<b>Participant 21 DUBLIN 11.1:</b> <i>"Yes, such obstacles still exist because if something, it's just like the health people telling us to go in the direction of eating healthy, but when you go to the supermarket, most of the things that are supposed to be healthy things are the most expensive. So, they are not very cheap for people to access. So, if things are made easier for people like commoners like us, to be able to get through to them. Of course, lots of people will jump at it"</i>
Level of Access to MHealth due to lack of awareness impacts MHealth System in/equalities.	<b>Participant 05. CORK 3.1:</b> <i>"Ignorance, so many people aren't aware of, of such app. So many people are not aware that they could, you know, be able to help themselves from their comfort zone. So, if people will be aware of it, I think it will help so much"</i>

Level of Access to MHealth due to lack of information impacts MHealth System in/equalities.

**Participant 11 GALWAY 6.1**

*Sometimes I hear people talk about it, but I never thought of it. And I don't think it's something that is serious you know. And I will say that I didn't develop interest until I was introduced to this particular one. And I now realize the benefit of that, you know, and it's something that I would like to keep up with, yeah.*

The validation process through the chain of evidence shows that the “levels of access” to MHealth is the result of variations arising from unavailable resources such as Internet connections, smartphones, MHealth devices, mobile software apps which impacts MHealth system inequalities. This validation leads us to propose that access to MHealth impacts upon MHealth System.

P1: Variation due to access or no access to MHealth impacts upon MHealth System



Figure 4. 3 Variation in access to MHealth impacts MHealth System Inequalities.

**4.3.2. Inequalities due to the variation in the suitability of MHealth equipment.**

Variations in the suitability of MHealth equipment were identified in the methodology section as an antecedent of inequalities in consumer MHealth. Suitability of MHealth equipment is defined as the adequacy of MHealth equipment, or the appropriateness of mobile devices and app for the task (DiMaggio & Hargittai, 2001; Feinberg et al., 2017; Vedanthan et al., 2015). The data analysis shows that unsuitable MHealth equipment arises from inferior or poor quality products, outdated devices, including legacy devices and silo systems (DiMaggio & Hargittai, 2001). Unsuitable systems can be sources of incompatibility with other devices, stemming from low quality in terms of functionality or even operational complexity for the PAB participants. Usually, good quality MHealth equipment have high-cost implications for some low socioeconomic populations who may prefer to buy cheap devices or to settle for “free services” which are mainly provided with hidden costs.

Usability is also an aspect of suitability, which is defined by the international organization for standardization (IOS) as “the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use” (Hornbæk, 2006; Wallis, Blessing, Dalwai, & Shin, 2017). To ensure suitability, national

and international institutions have to certify and regulate the quality of various health technologies, including MHealth devices (Hamel, Cortez, Cohen, & Kesselheim, 2014). For example, during this research some PAB participants complained that their Smartphone brands were incompatible with some MHealth devices. The suitability of some Smartphone brands such as Apple iPhone or Samsung were distinguished from unknown mobile phone brands. Similarly, unsuitable internet connection depends on variation in internet speed. Internet speed depends on technologies such as the Digital Subscriber Line (DSL), Cable Modems, Fibre Optics Cables, Wireless Radio Transmission etc. These technologies operate at different speeds and determine the suitability of Internet connection service. The PAB participants were linked to various types of internet services and speeds which were also affected by location and type of contract. The demographic data revealed that some of the PAB participants owned a broadband internet subscription with yearly or monthly contract, while few others were connected on pay-as-you-go internet service.

Similarly, the proliferation of MHealth app has paved ways for unregulated and unsuitable variation of health apps on the mobile app-store (Lupton, 2013, 2014; Schnall et al., 2016). There is proliferation of MHealth apps with doubtful characteristics in terms of quality, interconnectivity, data security and privacy . These challenges affect the variations of MHealth suitability for various users (Borrelli & Ritterband, 2015). Also, some MHealth consumers rely on free health apps with low quality of services .

#### 4.3.2.1. Inequality in the suitability of the MHealth equipment for PAB participants

Some PAB participants said they were unaware or did not find the need to acquire MHealth devices or apps. The research also revealed that some category of users, especially, those of the minority populations, have never been considered as target focus for the design and manufacture of consumer MHealth devices (Armaou et al., 2020; Schnall et al., 2016). These variations in MHealth suitability leave the PAB minorities in unequal position with the mainstream population whose interest are the design focus of MHealth innovation.

The excerpts from transcripts of interviews and memos of PAB participants show that unsuitability of MHealth equipment result from the variations in MHealth equipment due to:

- variation in the suitability of internet connection
- variation in the suitability of smartphone device
- variation in the suitability of mobile health application

- variation in the suitability of MHealth devices; for example, the digital activity sensor and digital weighing scale.

The variation in suitability of equipment according to the experience of PAB population represent a range of dichotomous concepts that describe and differentiate between suitable MHealth equipment versus unsuitable MHealth equipment. Table 4.5 is an illustrative example of the dimensional contrast or differential range that describe the participants' experiences of suitable versus unsuitable MHealth equipment.

**Table 4.5 Differential range that describes variation of suitability in MHealth equipment**

Dimensional contrast or differential range that describe variation of suitability of MHealth equipment			
Unequal suitability of MHealth equipment		Dimensional Contrast	Category
Inferior hardware	--	Superior Hardware	Unsuitable - Suitable
	-		
Inferior Software	--	Superior Software	
	-		
Proprietary devices	--	Standard devices	
	-		
Legacy System	--	Standard System	
	-		
Intra-operable system	--	Interoperable system	
	-		
Dysfunctional network	--	Functional Network	Suitability of Equipment
	-		
Not easy to use	--	Easy to use	
	-		
Not feasible	--	Feasible	
	-		
Not effective	--	effective	
	-		

#### 4.3.2.2. Citation evidence of variation due to suitability of MHealth equipment

The following is the chain of evidence that the variations in the suitability of MHealth equipment impacts upon MHealth system inequalities. Citation evidence shows that the variations in the suitability of MHealth equipment impacts upon MHealth system Inequalities. The citations below are extracts from PAB participant's interviews, the TAP and RPD Reports in which PAB participants conceptualised their experiences of the variations in suitability of MHealth.

**Table 4.6 Variation due to suitability of MHealth equipment impacts MHealth system**

P2- Variation due to suitability of MHealth equipment impacts upon MHealth system inequalities.	
<i>Variation factor</i>	<i>Participant and the citation evidence</i>
Suitability of MHealth equipment due to variation in portability of devices, impacts MHealth System in/equalities.	<b>Participant 15 GALWAY 8.1:</b> <i>“So, I’ve been monitoring for the weighing balance, or the scale is for monitoring my weight and see if I’ve change the weight since I started. So I’ve improved in weight, I’ve lost some weight but is not...em, is a few percent weight loss, which is not up to my target. But the wrist band, the wristband app is very, very good because always on the wrist hand, and it’s more is more portable. So, I carry it everyone to go”.</i>
Suitability of MHealth equipment due to variation in usefulness of devices, impacts MHealth System in/equalities.	<b>Participant 07. CORK 4.1:</b> <i>“App specifically. So, in my sleep when I did use it, it showed me how well I slept that night, how long I slept at night. I was useful in monitoring like you are checking which times I should be sleeping shouldn’t be sleeping, etc. So, my weight, the information it expanded on the information I got from just stepping on the weighing scale, which you just saw me, my weight on the weighing scale and the app would break it down they would show me the fat percentage and muscle percentage BMI body mass index, water percentage etc. It broke down the information made it easier to digest”.</i>
Suitability of MHealth equipment due to variation in interoperability of devices, impacts MHealth System in/equalities.	<b>Participant 05. CORK 3.1:</b> <i>“Actually, the first time was not too easy because of synchronizing it and the setup. So initially I was having a problem of setting it up and synchronising it...”</i>
Suitability of MHealth equipment due to variation in quality of devices, impacts MHealth System in/equalities.	<b>Participant 02. CORK 1.2:</b> <i>“The scale I think is really hard to use. Because if you’re sharing with other people, then there’s a lot of confusion at the state, unlike whose phone is getting the data from, but like I stopped using that I just use the step counter and sleep monitor and that’s very easy to use”.</i>
Suitability of MHealth equipment due to variation in compatibility of smartphone devices, impacts MHealth System in/equalities.	<b>Participant 18 DUBLIN 9.2:</b> <i>“Okay, okay. It’s good, if they can recommend it. But I think it will be okay if it will be able to access all phones because some phones are not compatible”.</i>
Suitability of MHealth equipment due to variation of interconnectivity of legacy systems or proprietary mobile phone devices, impacts MHealth System in/equalities.	<b>Participant 18 DUBLIN 9.2:</b> <i>“There are some phones, some digital phones, like some phones that’re made by different companies that can’t get in touch with the app properly, just like mine. And it can’t function with everything in it. So, I’ll see they should make it compatible for all digital platforms”.</i>
Suitability of MHealth equipment due to variation in form-factor (such as water-resistant devices), impacts MHealth System in/equalities.	<b>Participant 03. CORK 2.1:</b> <i>It’s to make it simple for people and modernize it in a way to be, it I’ll be easy for people to know. So as I say, to make the health app waterproof. And other things so that many people will like it and introduce it to people.</i>

The validation process in the chain of evidence shows that the levels of suitability of MHealth equipment are the result of variations arising from limited internet connection, incompatible Smartphones, proprietary MHealth devices and MHealth Apps, which impact MHealth System inequalities. This validation leads us to propose that variation due to suitability of MHealth equipment impacts upon MHealth system.

P2: Variation due to suitability of MHealth equipment impacts upon MHealth system

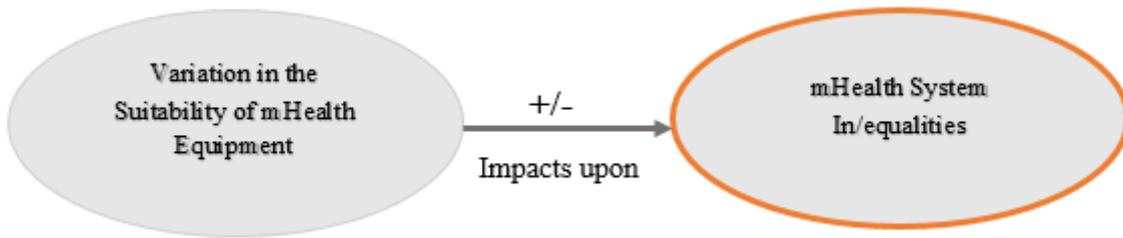


Figure 4.4 Variation due to suitability of MHealth equipment impacts MHealth System

#### 4.3.3. Inequalities due to variation in user autonomy of MHealth equipment

Variations in the autonomy of MHealth equipment was identified as an antecedent of inequalities in consumer MHealth. Autonomy of MHealth equipment is defined by the level of user control of the MHealth equipment for physical activity and fitness (DiMaggio & Hargittai, 2001). The inability of a user to exercise a full control of the MHealth equipment is a limitation that impacts the use of the devices. Suitability of the MHealth device may arise from the hardware interface, the software, or from the interworking of IT resources, such as the internet, and device accessories.

4.3.3.1. Levels of MHealth autonomy for PAB participants due to variations:

- Variation in autonomy or level of user control of the Internet connection
- Variation in autonomy or level of user control of the Smartphone device
- Variation in autonomy or level of user control of the Mobile health app, including de/centralised data management and protection in terms of data privacy and security.
- Variation in autonomy or level of user control of the MHealth devices, such as:
  - Digital Activity Sensor and Digital Weighing Scale.

The variation in autonomy of MHealth equipment according to the experience of PAB population represents a range of dichotomous concepts that describe and differentiate levels of control. Table 4.7 is an illustrative example of the dimensional contrast or differential range that describe the participants' experiences of +/- levels of autonomy due to MHealth equipment.

**Table 4.7 Differential range describes variation in autonomy of MHealth equipment**

Dimensional contrast or differential range that describe the variation in autonomy of MHealth equipment				
Unequal autonomy of MHealth equipment			Dimensional Contrast	Category
Centralised Control	--	Decentralised Control	Restricted/Control - Unrestricted	Autonomy of technology
Inflexible Resources	--	Flexible Resources		
Limited Time	--	Unlimited Time		
Limited internet	--	Unlimited Internet		
Regulated use	--	Unregulated use		

4.3.3.2. Citation evidence of variation in autonomy provided by MHealth equipment.

The following is the chain of evidence which shows that the variations in the ‘level of autonomy of MHealth equipment impacts upon MHealth system inequalities. Citation evidence shows that the variations due to level of autonomy provided by MHealth equipment impacts upon MHealth system inequalities. The citations below are extracts from PAB participant’s interviews, the TAP and RPD reports in which they conceptualised their experiences of the variations in autonomy of MHealth equipment.

**Table 4.8 Variation in MHealth equipment autonomy impacts MHealth System**

<i>P3- Variation in the level of autonomy provided by MHealth equipment impacts upon MHealth system inequalities</i>	
<i>Variation factor</i>	<i>Participant and the citation evidence</i>
Level of Autonomy of MHealth due to variation in user interface control, impacts MHealth System in/equalities.	<b>Participant 07. CORK 4.1:</b> “It’s, I think I briefly touched on this point before with the Samsung adopters Is it the user interface, I don’t know how exactly to call it. But if the amount of involvement of the user of the app like it, there are some apps that require more involvement and that can lead to some problems like but the watch in the required you to go to the sleep mode and then activate the sleep mode and then when you’re done and you wake up the next morning, you have to turn it off exactly when you wake up which is a problem because people will be tired some nights when going to sleep they will not remember, they’re tired. Some mornings they wake up, but they don’t remember. And it’s if there was some way to like to have a complete hands-off approach and I tend to be lazy and just practical practicality and it’s just it just be more efficient that way”.
Level of Autonomy of MHealth due to variation in user control of internet connection impacts MHealth System in/equalities.	<b>Participant TAP &amp; RPD STEP 55:</b> “The participant noted that his experience with the MHealth was rewarding, and not stressful. The MHealth experience was also facilitated by the use of smartphone with unlimited mobile broadband internet connection”.
Level of Autonomy of MHealth due to variation in automation of MHealth devices impacts MHealth System in/equalities.	<b>Participant 05. CORK 3.1:</b> “So, I think if this one will be coming automatic, I think that will be one of the good things that will make the app better, more suitable for people to [control]use”
Level of Autonomy of MHealth due to variation in ubiquity of MHealth impacts MHealth System in/equalities.	<b>Participant 01. CORK 1.1 TAP &amp; RPD STEP 55:</b> “Whether you are on holiday, business trip or at the doctor’s clinic, the application allows you to always view and track your values. Switch easily between weight, blood pressure, activity and sleep”.

Levels of autonomy in MHealth equipment is the result of variations arising from restricted internet connection, incompatible Smartphones, un-automated MHealth devices, de/centralised control of MHealth data, which impact MHealth system inequalities. The validation in the chain of evidence leads to the proposition that variation in MHealth equipment autonomy impacts MHealth System.

P3: Variation in the level of autonomy provided by MHealth equipment impacts upon MHealth system

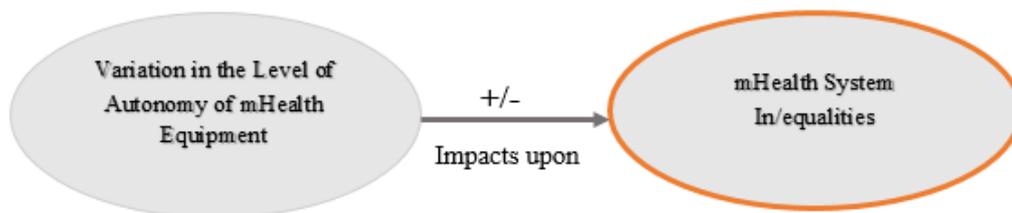


Figure 4.5 Variation in autonomy of MHealth equipment impacts MHealth system

#### 4.3.4. Inequalities due to the variation in user perceived benefits of MHealth

Variations in user perceived benefits of MHealth is an antecedent of inequalities in consumer MHealth. User perceived benefits or usefulness of MHealth was defined as “the degree to which a person believes that using a particular system would enhance his or her job performance” (Davis, 1989; Jeongeun Kim & Park, 2012). The PAB data shows the perceived usefulness of MHealth in the benefits which they identified in the MHealth for physical activity and fitness.

4.3.4.1. Regimented indoor exercises were unattractive to PAB individuals.

Discussion about MHealth related benefits in terms of regimented physical exercise may traditionally be a misnomer for PAB individuals. PAB participants say that regimented physical exercise is more of a professional activity, which in the African context is provided for institutions. The African context shows that priority is given to outdoor physical exercises more than regimented indoor activities. This is perhaps due to the hot climate, as well as cultural and environmental factors that necessitate outdoor lifestyle in Africa.

Moreover, in rural African communities, physical exercise is enshrined in the everyday living around domestic, agricultural, commercial, and social activities. For example, unregimented exercises and physical fitness would naturally be part of social events involving traditional dance groups and including the masquerade dances, as well as dancing at religious worships.

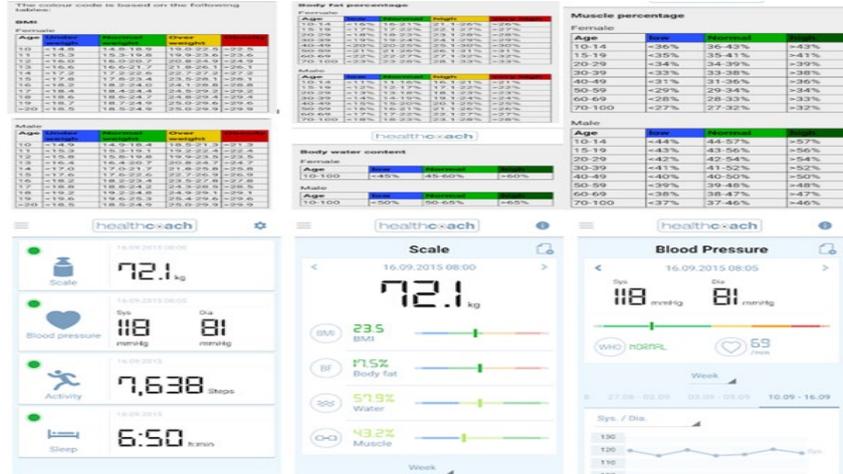
There is a common saying among African people, that if you find someone running, there must be something chasing him or her. The perception of regimented physical exercise was not very attractive to most PAB individuals. It is to be noted that PAB participants of rural African origin may be more active in unregimented physical activity and fitness which are traditionally part of social, cultural, religious activities in everyday life. In this way the PAB physical fitness and health are affected by environmental factors, such as weather conditions.

#### 4.3.4.2. User perceived benefits of MHealth for PAB participants

Most PAB participant initially commented that the MHealth PAF would not be useful to them. However, the research findings show that during the TAP and RPD protocols, the PAB individuals identified that the MHealth had more benefits than they initially thought. PAB participants understood that MHealth PAF was able to capture and communicate PAF information personally and socially. The MHealth communicated PAF information in the forms of sound, vibrations, and visual colours, as well as data tables and other graphical displays were easy for PAB to understand. MHealth communication of information includes activity reminders, colour display of information, provision of health charts such as body mass index BMI charts and health tables. The MHealth PAF displayed health information using symbolic icons, colour coded bars, historical summaries for weekly, monthly, and yearly fitness data. MHealth PAF provided fitness information tables, including weight tables and body mass index (BMI) tables and charts for PAB participants. The MHealth made fitness information easy to understand by using colour-bar indicators to identify categories of weight. For example, the MHealth colour-bar displayed blue colour to indicate underweight, green for normal weight, yellow for overweight and red for obesity. Table 4.9 shows various snapshots of tables of information, and activity data of the MHealth display. Table 4.10 shows an example of colour coded PAB data on MHealth PAF from the observation report during installation with TAP.

**Table 4.9 Reference information Tables, and user’s activity data display on MHealth**

Displayed image is the property of its rightful owner; adopted from: Sanitas HealthCoach App (Sanitas-online, 2021); adapted for illustration.



**Table 4.10 Colour coded PAB data on MHealth during installation with TAP**

*mHealth TAP Installation Tasks (Steps 21-27)*

INSTALLATION OF MHEALTH (TASK STEPS 21-27)		Incident encounter	Health data Day 1				Health data Last Day				
21	Record the data on Health-coach and the corresponding colours										
22	o Weight in kg		102.6								
				Under weight	Normal weight	Over weight	Obesity				
23	o BMI	x			29.3			Under Weight	Normal Weight	Overweight	Obesity
24	o Read Body Fat	x				27.6					
25	o Read Water	x	46.2								
26	o Muscle	x			36.5						
27	Close Health-coach App										
	Incidents counts out of the total	11/27									
	Time Duration of Think-Along										

4.3.4.3. Citation evidence of variation in the user perceived benefits of MHealth

The following is the chain of evidence which shows that the variations in the user ‘perceived benefits of MHealth impacts upon MHealth utilisation inequalities. Citation evidence shows that the variations in the level of perceived benefits of MHealth impacts upon MHealth utilisation inequalities. The citations (Table 4.11) are extracts from PAB participant’s interviews, the TAP and RPD reports in which they conceptualised their perceptions of the benefits of MHealth.

**Table 4.11 Variation in the perceived benefits of MHealth’ impacts MHealth utilisation**

<i>P4- Variation in the perceived benefits of MHealth impacts upon MHealth utilisation inequalities</i>	
<i>Variation factor</i>	<i>Participant and the citation evidence</i>
Perceived benefits of MHealth for tracking physical activity and fitness (PAF) information:	<b>Participant 04. CORK 2.2:</b> <i>“When I started my BMI was almost a yellow yellowish. My body fat was red. My water was between yellow and red. Then my muscle was yellow and green and green. But now my muscle is green. My water level green, my body fats is Yellow, strong green, nearly two grey. Then BMI is green. A very big, massive improvement”.</i>
Perceived benefits in terms of ubiquitous access to personal PA and fitness information.	<b>Participant 07. CORK 4.1:</b> <i>“It was really good if you just want to quickly look at something and know whether it's increasing or decreasing self-checking numbers and crunching facts you just look at a chart and it shows a graph that says clearly increasing. That was that was really useful”.</i>
Perceived benefits in terms of continuous monitoring PA and fitness information	<b>Participant 11 GALWAY 6.1:</b> <i>“Then with this health coach, I was able to, you know, monitor the water intake and that day and how many, you know, my body weight and the muscle and all those other things. And it kind of an eye opener because when I started I mean most of the things were on the other side of it; but when I know that there's a target that I was meant to be on the green side, I started walking towards that”.</i>
Perceived benefits in terms of motivation for ubiquitous PA and fitness participation	<b>Participant 12 GALWAY 6.2:</b> <i>“Maybe a lot of improvement o. Because whenever I'm, if I know that I'm working, and I'm going to be on the floor, I'm always happy, because I know I'll get my targets. I set up 10,000 targets. And whenever I like to make up the targets to 10,000, even if it's not to that bit. At least, almost 90%. And I'm happy about that”.</i>
Positive evidence such as reduced number of GP visits and reduced number of emergencies calls due to personal self-care and prevention	<b>Participant 04. CORK 2.2:</b> <i>“Very, very, very, very, very helpful and very grateful and appreciate it. If they put it for everybody. It's good to use to monitor yourself. They say prevention is better than cure. If you can prevent it before going to a GP you know, you take care of yourself and know what to eat or know what to do. And if something is going wrong you know what to do earlier before going to GP. You know, like now we have if you can see in Cork, how many people lying down in bed something beds hospital beds, so so many people. But if this thing can be introduced in every house in every household, we take care of ourselves our home before taking us to hospital. So that's why it's very important. Like to be honest, I have not gone to my GP to check my BP and we are monitoring this every day”.</i>
Feedback information on fitness and dieting	<b>Participant 23. DUBLIN 12.1:</b> <i>“So, with this health coach, it's motivated me I don't like drinking water. So, but what I did this in this scenario was I had to put lemon, add lemon to my water just to bring up my water level in the body”.</i>

Levels of perceived benefits of MHealth are the result of variations arising from perceived usefulness of MHealth devices and Apps, reduced number of GP visits, positive feedback on fitness, and corroboration from personal diets; and all these variations impact MHealth utilisation inequalities. The validation in the chain of evidence leads to the proposition that variation in the user perceived benefits of MHealth impacts upon MHealth utilisation.

#### P4: Variation in the user perceived benefits of MHealth impacts upon MHealth utilisation

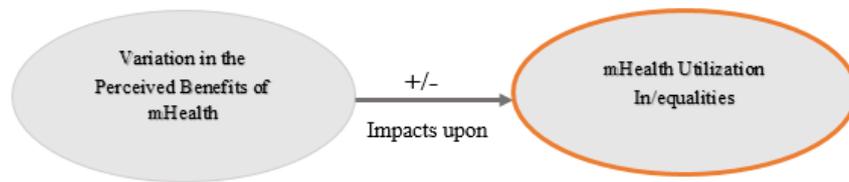


Figure 4.6 Variation in Perceived Benefits of MHealth impacts MHealth Utilisation

#### 4.3.5. Inequalities due to variation in Perceived Constraints of MHealth

Variations in user perceived constraints of MHealth was identified as an antecedent of inequalities in consumer MHealth. User perceived constraints of MHealth are perceived barriers or inhibitions associated with demotivation in the use of MHealth innovation (Alexandris, Tsorbatzoudis, & Grouios, 2002). Perceived constraints of innovation can be associated with the technology, the user or related to the task. Perceived constraints include the complexity or otherwise the ease of use of technology, defined as “the degree to which using an innovation is perceived as being difficult to use” (Moore & Benbasat, 1991; Venkatesh, Morris, Davis, & Davis, 2003). The complexity or otherwise the simplicity of health technology innovation has tremendous impact on user perception (Chang & Lauderdale, 2009).

The fundamental cause theory, posits that “the introduction of technologies can lead to disparities” based on their complexity or otherwise on the simplicity of the innovation (Chang & Lauderdale, 2009, p. 248; Goldman & Lakdawalla, 2005). The user perceived constraints of MHealth for physical activity and fitness is a measure of perceived difficulty to use the MHealth innovation (Thompson, Higgins, & Howell, 1991).

##### 4.3.5.1. Variations in user perceived constraints of MHealth for PAB participants

The excerpts from transcripts of interviews and notes of observation of PAB participants identified the various perceived constraints of MHealth that hinder the proper utilisation of MHealth. Some PAB participants identified operational complexity as one of MHealth constraints. The operational complexity was associated with the difficulty in the hardware user interface and in the non-automated functions of the devices, as well as the software operational difficulties. PAB participants also identified personal lack of time due to work or family.

#### 4.3.5.2. Citation evidence of variation in the user perceived constraints of MHealth

The following is the chain of Evidence that the variations in the user perceived constraints of MHealth impacts upon MHealth utilisation inequalities. Citation evidence shows that the variations in the perceived constraints of MHealth impacts upon MHealth utilisation inequalities. The citations (Table 4.12) are extracts from PAB participant’s interviews, the TAP and RPD reports in which they conceptualised their perceived constraints of MHealth during the research.

**Table 4.12 Variation in perceived constraints of MHealth impacts MHealth utilisation**

<i>P5- Variation in the perceived constraints of MHealth impacts upon MHealth utilisation inequalities</i>	
<i>Variation factor</i>	<i>Participant and the citation evidence</i>
participants experienced ‘Ostrich Problem’ (Webb, Chang, & Benn, 2013), a situation where seeing poor weight outcome caused discouragement rather than encouragement to continue	<b>Participant 20 DUBLIN 10.2</b> “... when I weigh myself often it makes me to really have a bad day and I stopped. You know because it doesn't really give me what I want. So, I stopped...”
Operational complexity of MHealth is a barrier	<b>Participant 23. DUBLIN 12.1</b> “Actually, I had to one of the days called my friend to help me out on how to use the weighing scale, and even the synchronizing, especially my sleep pattern. So, but right now, I still have slight difficulty in the weighing but every other thing, synchronizing my steps in a getting better. And, my sleeping pattern is not a problem”.
Installation set-up and synchronisation are barriers	<b>Participant 05. CORK 3.1</b> “Actually, the first time was not too easy because of synchronizing it and the setup. So initially I was having a problem of setting it up and synchronising it”.
Participants have limited time for MHealth physical activities	<b>Participant 04. CORK 2.2:</b> “And also, the time you know like what I said before I hardly do exercise because I was so busy. So these people are busy as well and they have no time to engage in any exercises. So that's the challenges”.
Participants are busy with family	<b>Participant 04. CORK 2.2:</b> “So, by the time you take the children to school, some of the activities and housework and your own walk, you know, you find out that you have no time for the exercise and all those things. I think that's one of the major problems again, I see that is hampering the usage of this”.
Participants have limited time because of work or family	<b>Participant 05. CORK 3.1:</b> “Actually, I find it difficult to involve in some of this exercise because of my work schedules and family engagement. My kind of business is demanding a lot of time and to find time to go into exercise is very difficult for me. Any little time I have I use it to sleep because that is one of the things I need in my work. So, all other little time then is to pick the children and you know assist in the family things. Because you know this part of the world, you need to assist your wife, to get the best out of the family. So, I find it a little bit difficult and having time to do exercise in most cases”.
limited knowledge and required skills of MHealth is a barrier	<b>Participant 04. CORK 2.2:</b> “At the beginning of my usage of this app it was hard because I'm not computer, I'm not computer literate. But as time goes on, I start getting used to it. And towards this end, now, I think I can manoeuvre whatever that is in there, to suit my need”.
Cost of MHealth is not affordable	<b>Participant 04. CORK 2.2</b> “...another problem and make it affordable”.

Participants identified other variation factors which include, variation:

- due to lack of technical experience
- due to limited interoperability skills for digital devices

The levels of perceived constraints of MHealth are the results of variations arising from the complexity of MHealth devices and Apps, limited personal time, and technical malfunctions due to lack of connectivity, interoperability, and synchronisation; and all these variations impact upon MHealth utilisation inequalities. The validation in the chain of evidence leads to the proposition that variation in the user perceived constraints of MHealth impacts upon MHealth utilisation.

P5: Variation in the user perceived constraints of MHealth impacts upon MHealth utilisation

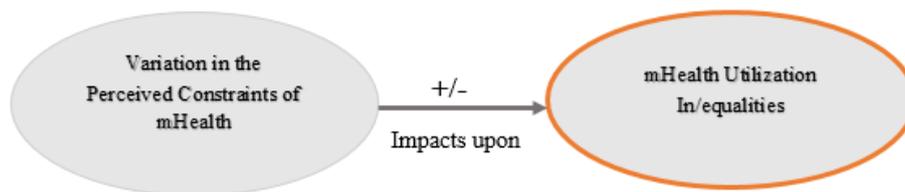


Figure 4.7 Variation in user perceived constraints of MHealth impacts MHealth utilisation

#### 4.3.6. Inequality due to the variation in demographic and socioeconomic factors

Demographic and socioeconomic variables were shown to contribute to inequalities in consumer MHealth. The disadvantages imposed by demographic factors are represented in the PAB characteristics captured in the survey. The sociodemographic disadvantages include factors related to age, education, employment, income, location, race, and culture. The socioeconomic themes include racial stereotyping, lack of contact and mistrust of medical professionals, unfamiliarity with foreign specialists, the lack of specialists from African populations, language barriers and cultural barriers, including high cost of MHealth devices.

##### 4.3.6.1. Variations in demographic and socioeconomic factors for PAB participants

It was noted in the methodology chapter that most PAB participants who were below the age of thirty understood the technology more easily due to their possession of IT skills and experiences. Although the available data is insufficient to make accurate predictions but younger ages below 30 years were more likely to have better IT skills as indicated by the survey. Apart from age, the demographic survey showed that students thrived better in the use

of the MHealth than the older age working class. Further investigation is required to understand all the PAB characteristics which can provide rich information.

#### 4.3.6.2. Citation evidence of variation in demographic and socioeconomic factors

The following is the chain of Evidence that the variations in demographic and socioeconomic factors impacts upon MHealth utilisation inequalities. Citation evidence shows that the variations imposed by demographic and socioeconomic factors impacts upon MHealth utilisation inequalities. The citations below are extracts from PAB participant’s interviews, the TAP and RPD reports in which they expressed their experiences due to socioeconomic and demographic differences.

**Table 4.13 Variation in socio-demographic factors impact MHealth utilisation**

<b>P6- Variation in demographic and socioeconomic factors impacts upon MHealth utilisation inequalities.</b>	
<b>Variation factor</b>	<b>Participant and the citation evidence</b>
Personal health status	<b>Participant 14 GALWAY 7.2:</b> “Before now I was going to the gym every, let's say four times in a week for like, two hours. But now of course I have an injury. I haven't been doing that”.
Culture	<b>Participant 06. CORK 3.2:</b> “My diet, like the food we eat as Africans has a lot of saturated fat in it and you need to do, you need to involve yourself in a rigorous exercise to get that fat out of your system when it's already in there”.
Age and education	<b>Participant 02. CORK 1.2:</b> “But I use the step counter a lot. Like when I was walking to school, I would already know how many I would get from that. And when I'm walking from class to class, and also when I come back from school and when I walk my dog, and I try usually to get around 10,000 steps per day, and if I don't, then I'll try walk out my house a bit more to get more steps because it was important for me to reach the goal”.
Employment and income	<b>Participant 05. CORK 3.1:</b> “Honestly, this is all about life, if everybody will have an access where they can be able to check their fitness and find out the state of their health, that'll be so perfect. But, because everybody wants life I know it's as a result of people's different categories of work or riches or assets to finance. Otherwise, it is something that should be made to be common, especially to the poor. That means if the poor don't have an insurance, they will not live. So, remember, we're talking about his life and living”.
Complaining of cost of MHealth	<b>Participant 21 DUBLIN 11.1</b> “Well, I would say the first thing is this one came easy, it was free. Which means if health can be made accessible to people and make cheap enough it will encourage A lot of people to get into it. So, for me, I have never considered any app to be able to help me to improve my lifestyle until I came in touch with this. And because it was free, it didn't cost me anything”.

Levels of Variations due to demographic and socioeconomic factors are the result of variations arising from age, education, employment, culture, and income; and all these variations impact upon MHealth utilisation inequalities. The validation in the chain of evidence leads to the proposition that variation in demographic and socioeconomic factors impacts upon MHealth utilisation.

P6: Variation in demographic and socioeconomic factors impacts upon MHealth utilisation.

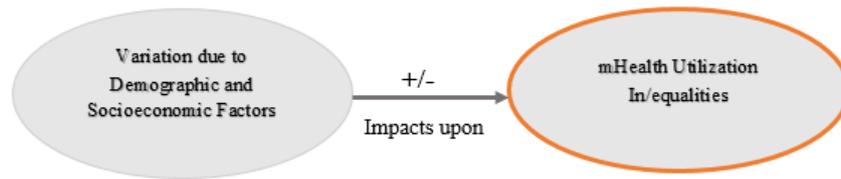


Figure 4.8 Variation in demographic and socioeconomic factors impacts MHealth

#### 4.3.7. Inequalities due to the variation in the level of MHealth advocacy

Variations in the level of MHealth advocacy is one of the antecedents of inequalities in consumer MHealth. MHealth advocacy is the strategic use of information and resources to systematically promote MHealth, by targeting specific individuals and those with whom they live, and the larger social networks or community to which individuals are tied. (Chapman, 2004; Christoffel, 2000). MHealth advocacy during this research focused on the use of MHealth for physical activity and fitness (PAF), to enlighten PAB individuals and community (Health & Children, 2009; Macpherson et al., 2009). MHealth advocacy encompasses direct services to the individual or family, as well as activities that promote MHealth for access to health care in communities (Christoffel, 2000).

##### 4.3.7.1. Variations in the level of MHealth advocacy for PAB participants

The PAB participants are isolated minorities of African background living among the mainstream population. Minorities have limited network of families, friends and community contacts in the societies in which they belong. (Mutwarasibo, 2002; Triandafyllidou, 2009). This is the case of PAB population with limited contacts of family and friends within the mainstream population whose generations dominate the social and economic society. Generations of minorities of African origin such as the PAB find themselves adjusting in an unfamiliar society and environment, including association and information sharing (Weiss & Eikemo, 2017).

In the methodology chapter, the researcher played some MHealth advocacy role in the execution of the TAP and RPD protocols. The TAP and RPD were parts of MHealth PAF advocacy which targeted PAB individuals and community for MHealth enlightenment and demonstration (Health & Children, 2009). The excerpts from transcripts of interviews and reports of PAB participants show that the variations in the level of MHealth PAF advocacy is

the result of the variations in MHealth information, resources, and strategic promotion which impact MHealth communication inequalities.

#### 4.3.7.2. Citation evidence of variation in the level of MHealth advocacy

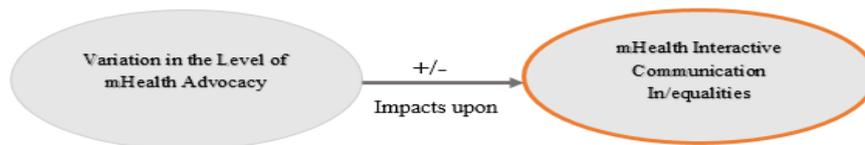
The following is the chain of evidence to show that the variations in the level of MHealth advocacy impacts upon MHealth interactive communication inequalities. Citation evidence to show that the variations in the level of MHealth advocacy impacts upon MHealth interactive communication inequalities. The citations (Table 4.14) are extracts from PAB participant’s interviews, the TAP and RPD reports in which they conceptualised their experiences of the variations in MHealth advocacy that impacts MHealth communication.

**Table 4.14 Variation in the level of MHealth advocacy impacts MHealth communication**

<i>P7- Variation in the level of MHealth advocacy impacts upon MHealth communication inequalities.</i>	
<b>Variation factor</b>	<b>Participant and the citation evidence</b>
Variations in knowledge of MHealth Physical Activity and Fitness Guidelines	<b>Participant 23. DUBLIN 12.1:</b> “Sitting in a place for a long time or lack of exercise can cause one to be obese. It can also trigger some risk factors associated with maybe diabetes or high blood pressure and then, so it is very, very, you know, it’s good to for someone to actually put in at least 30 minutes a day, as part of exercise just to keep fit, even when you think you’re very healthy, or you’re healthy”.
Create awareness of the risk of sedentary lifestyle	<b>Participant 23. DUBLIN 12.1:</b> “It does a little bit because as most times I like to sit down watch my [TV] Television, especially the movies, but I’m sacrificing my movie time to just exercise. So I will say yes”.
Create enlightenment of MHealth PAF through family interaction	<b>Participant 10 GALWAY 5.2:</b> “It was good, with my husband, sometimes we will discuss who did what and how many steps you’ve done. I guess the more family members are involved, the better. We can then all kind of compete with each other and see who’s done more. We use something similar in Boston Scientific at work and it’s very encouraging. And translating it into competition encourages people to do better and to do more”.
Draw attention to MHealth messages and activities	<b>Participant 16 GALWAY 8.2:</b> “Because nobody has told me about any mobile app or Health app or whatever, until you introduced it. And honestly, that’s the best thing”.
Create awareness of sedentary risk factors	<b>Participant 23. DUBLIN 12.1:</b> “It does a little bit because as most times I like to sit down watch my Telly, especially the movies, but I’m sacrificing my movie time to just exercise. So I will say yes”.
Importance of user’s trust relationship with national MHealth service and staff	<b>Participant 07. CORK 4.1:</b> “If it’s recommended by the National Health Service, then that’s a big deal. So, you’d have to take the word seriously like it’s officially recognized like, organization”.
Free MHealth incentive supports free boost of public health promotion	<b>Participant 21 DUBLIN 11.1</b> “Well, I would say the first thing is this one came easy, it was free. Which means if health can be made accessible to people and make cheap enough it will encourage A lot of people to get into it. So, for me, I have never considered any app to be able to help me to improve my lifestyle until I came in touch with this. And because it was free, it didn’t cost me anything”.

Levels of MHealth advocacy is the result of variations in the MHealth information about the risk of sedentary lifestyle, available MHealth resources; and all these variations impact MHealth interactive communication inequalities. The validation in the chain of evidence leads to the proposition that variation in the level of MHealth advocacy impacts MHealth interactive communication.

P7: Variation in the level of MHealth advocacy impacts MHealth interactive communication



**Figure 4.9 Variation in MHealth advocacy impacts MHealth interactive communication**

#### **4.3.8. Inequalities due to the variation in the level of social network in MHealth.**

Variations in MHealth social network is an antecedent of inequalities in consumer MHealth. MHealth social network is “the web of social relationships” that surround specific individuals and those with whom they live, and the larger community to which the individuals are tied (Christoffel, 2000; Heaney & Israel, 2008).

##### 4.3.8.1. Variations in the level of MHealth social networks for PAB participant

For the PAB participants, the MHealth social network includes the interpersonal links with family members, friends, peers, and social links with communities. Also, these interpersonal links are extended by the virtual network of the internet, with mobile and the wireless connection. By using the MHealth PAF, the PAB participants were able to interact in their discussions with family, and with peers, as well as interact online media with the researcher. The excerpts from transcripts of interviews and TAP/RPD reports contain the MHealth social network centred on the families of PAB participants.

##### 4.3.8.2. Citation evidence of variation in the level of social network in MHealth

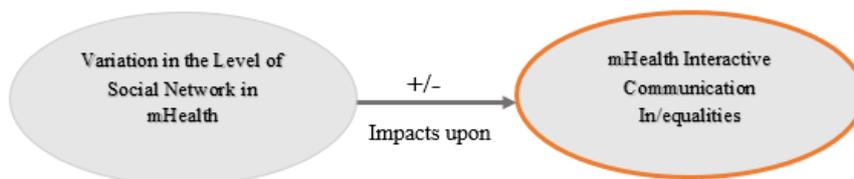
The following is the chain of evidence that the variations in the level of social network in MHealth impacts upon MHealth interactive communication inequalities. Citation evidence to show that the variations in the level of social network in MHealth impacts upon MHealth interactive communication inequalities. The citations in Table 4.15 are extracts from PAB participant’s interviews, showing TAP and RPD reports in which they conceptualised their experiences of the variations in MHealth social network.

**Table 4.15 Variation in MHealth social network impacts MHealth communication**

<b>P8- Variation in the level of social network impacts upon MHealth interactive communications.</b>	
<b>Variation factor</b>	<b>Participant and the citation evidence</b>
Variation in level of MHealth Social network based on family circle	<b>Participant 02. CORK 1.2:</b> <i>“When I was using the step counter, it would help me to track my fitness level and see if I was being active enough because if I'm sitting too much, that makes me not feel healthy. And so I can get proof of that from the watch. And also I compared it to my dad or sister, and then encouraged them to do more exercise if the number was low”.</i>
Variation in MHealth Social Network based on household	<b>Participant 23. DUBLIN 12.1:</b> <i>“And I make it that way everyone is aware of it in my in my house. In fact, my kids now the anytime I start my jogging, they're interested, mommy I'm going with you. My friends at work even those that have not heard about it, especially if you're with me checking my hand. I'm sometimes I will say to them, hey, oh my God I haven't met my target, I have to run off now. At work, I'm saying at work. So, I have made it aware to most of my friends at work, that this is the in-thing, they need to do it”.</i>
Variation in MHealth Social Network based on husband, wife and children	<b>Participant 23. DUBLIN 12.1:</b> <i>“It helped, and my daughter was also part of this program. Sometimes when she comes back, the first thing she asked is Mommy, did you reach your target? And sometimes, she too, she will not reach her target. So, both of us and my son that was not even part of it, they got interest in it so we all we jog up and down and sometimes my my husband, you know, it's funny, it's funny I'm like he's he's joking with me about it. And if you can find in the house is really a good motivator”.</i>
Variation in level of MHealth Social Network due to political and social integration or otherwise isolation	<b>Participant 09. GALWAY 5.1:</b> <i>“I do but not really interested in politics [and voting]”.</i>

Levels of MHealth social network is the result of variations in the web of family circle, network of friends and peers, and social and political isolation; and all these variations impact MHealth interactive communication inequalities. The validation in the chain of evidence leads to the proposition that variation in the level of MHealth social network impacts MHealth communication.

P8: Variation in the level of MHealth social network impacts MHealth communication



**Figure 4.10 Variation in social networks impacts MHealth communication**

#### **4.3.9. Inequalities due to the variation in the level of social support in MHealth.**

Variations in MHealth social support is an antecedent of inequalities in consumer MHealth. MHealth social material support is the social influence, companionship, and support arising from the web of social relationships that surround specific individuals and those with whom they live, and the larger community to which the individuals are tied (Christoffel, 2000; Glanz, Rimer, & Viswanath, 2008a; Heaney & Israel, 2008).

##### **4.3.9.1. Variations in the level of MHealth social support for PAB participant**

During the research, the PAB participants received technical, material, and interactive support from the researcher (See TAP/RPD Appendix F). During the usage period of the MHealth the PAB participants were advised to contact the researcher whenever they required technical support. The PAB participants contacted the researcher mainly by phone calls and WhatsApp calls and messaging services. The researcher was able to deliver technical support and advice relating to MHealth. The researcher directed the PAB individuals on various issues to help them use the MHealth during the eight weeks period. The excerpts from transcripts of interviews and reports from PAB participants show that MHealth social and material support result from variations in support due to social influence, companionship, and support arising from interpersonal relationships.

##### **4.3.9.2. Citation evidence in the variation of the level of social support in MHealth**

Chain of evidence shows that the variations in the level of social support in MHealth impacts upon MHealth interactive communication inequalities. Citation evidence supports that the variations in the level of social support in MHealth impacts upon MHealth interactive communication inequalities. The citations (Table 4.16) are extracts from PAB participant's interviews, the TAP and RPD reports in which they conceptualised their experiences of the variations in social influence, companionship, and support arising from interpersonal relationships which impacted interactive communication.

**Table 4.16 Variation in the social support impacts MHealth communication**

<b>P9- Variation in the level of MHealth in social and material support impacts upon MHealth interactive communication inequalities</b>	
<b>Variation factor</b>	<b>Participant and the citation evidence</b>
Variation in level of MHealth Interactive Communication is influenced by knowledge within family members	<b>Participant 04. CORK 2.2:</b> <i>“Yeah, like myself and my husband, we used it. We always compare how many steps I do today. So, if he's not taking enough step, I said, Man, you have to start walking, even if it's by just your house. Yeah, just involve yourself in going around. Just to make to just be you must be busy doing something not sitting down. So, so we always discuss about how many steps we have, and we discuss about our water level, and you know, everything about the app. So, we need to push ourselves. And we must try and get to so so, steps, or so thing for your way, you know. We always look at our weight, So it has helped us both. My kids also they always ask hi, mommy how're getting on with it. How're you getting on with it. Yeah, I'm getting the so can we see Can we see? So, they also get involved just to know how if we have improved or not. So do they will say yesterday you improved, we want you to get more in order to reduce. We want you to do this or do this. So, we just discussed about this as a family”.</i>
Variation in level of MHealth Interactive Communication is influenced by interest among friends	<b>Participant 9 GALWAY 5.1:</b> <i>“In that regard, I could say that it kind of generated interest amongst my friends and they wanted to be part of the program. And sincerely speaking it actually motivated a few of my friends to start getting more active and change certain things in their lifestyle”.</i>
Variation in level of MHealth Interactive Communication is influenced by family members and peers at workplace	<b>Participant 10 GALWAY 5.2:</b> <i>“It was good, with my husband, sometimes we will discuss who did what and how many steps you've done. I guess the more family members are involved, the better. We can then all kind of compete with each other and see who's done more. We use something similar in Boston Scientific at work and it's very encouraging. And translating it into competition encourages people to do better and to do more”.</i>
Variation in level of MHealth Interactive Communication can be network of other “people”.	<b>Participant 04. CORK 2.2:</b> <i>“Yeah, people do ask me. What was this about? So, I'll always tell them. And I will just show them the information that I transferred from the app to my phone. They will like, oh, they like it. And it's very nice. I just showed them everything. So, they're happy, they want to start using it. They they know that it's just at a glance you know about your health. Now but everything about yourself at a glance without somebody telling you because the app is transferred to your phone and then you everything will just show you. Yes, you're improving, or you're not improving or anything about your health. When you're going to the GP, so you get the information. So, I just showed them, they were happy”.</i>
Variation in level of MHealth Interactive Communication can be influenced by the trust relationship with National Health Service	<b>Participant 08. CORK 4.2:</b> <i>“If it was approved by health service, I would definitely take it more seriously, as it's just proven to be generally more beneficial to you so I would take it more seriously”.</i>
Variation in level of MHealth Interactive Communication depends on the importance placed on good relationship with National Health Service staff.	<b>PAB Participant 01. CORK 1.1:</b> <i>“Yes, if it's from the health service I'll take it more seriously. Because I would take it like it's my prescription that I get from Doctor. So I'll be more serious about it if the Doctor tells me, see this, do this every day. Do this twice a day, or three times a day. I will try to do what the Doctor tells me, and not to miss any one of it, so that I will get, I will get my health very easily going. But it's not from the Doctor”.</i>

Levels of MHealth social and material support are the result of variations in the influence, companionship, and support arising from the web of family circle, network of friends and peers, and support from health organisations; and all these variations impact MHealth interactive communication inequalities. The validation in the chain of evidence leads to the proposition that variation in MHealth social support impacts upon MHealth communication.

P9: Variation in MHealth social support impacts upon MHealth communication

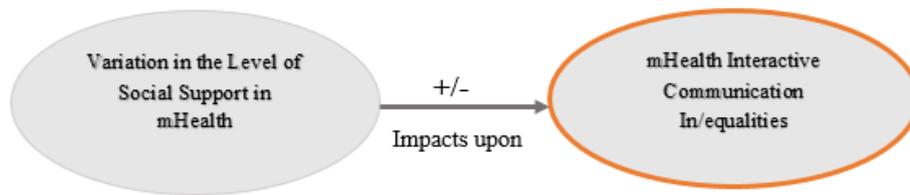


Figure 4.11 Variation in MHealth social support impacts MHealth communication

#### 4.4. Intermediate Factors of Inequalities in Consumer MHealth

The research findings show that the antecedents of inequalities in consumer MHealth are formative constructs of first-order hierarchical model. The nine antecedents of inequalities are linked to the intermediate factors. The intermediate factors are, 1. MHealth system, 2. MHealth utilisation, 3. MHealth Communication.

Every intermediate factor is further discussed in this section as a beginning for the validation process. The aim of the validation is to certify the credibility of the constructs by tracing through the chain of evidence back to the source (collected data). A successful validation of the intermediate factor leads to a proposition.

The MHealth system inequalities compose of three antecedent factors ((Table 3.27; Figure 3.14) which relate to the following propositions:

- P1: Variation in the level of Access to MHealth impacts upon MHealth System Inequalities.
- P2: Variation in the level of Suitability of MHealth Equipment impacts upon MHealth System.
- P3: Variation in the level of Autonomy of MHealth Equipment impacts upon MHealth System.

The path diagram in Figure 4.12 illustrates antecedents connect to the MHealth system.

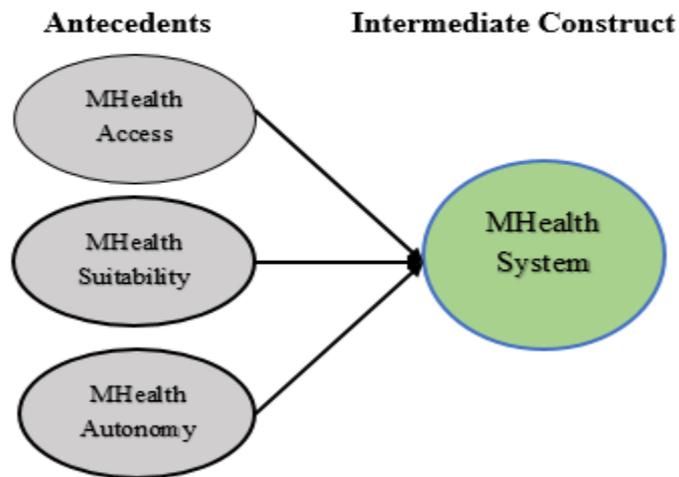


Figure 4.12 Antecedents of MHealth inequalities and the link to MHealth system

#### 4.4.1. MHealth utilisation inequalities relate with three antecedents:

The MHealth utilisation inequalities relate with three antecedent factors ((Table 3.28; Figure 3.15) which relate to the following propositions:

P4: Variation in the level of Perceived Benefits of MHealth impacts upon MHealth Utilisation.

P5: Variation in Perceived Constraints of MHealth impacts upon MHealth Utilisation.

P6: Variation in Demographic and Socioeconomic Factors impacts upon MHealth Utilisation.

The path diagram in Figure 4.13 illustrates the antecedents and how they link to the intermediate factor, MHealth utilisation.

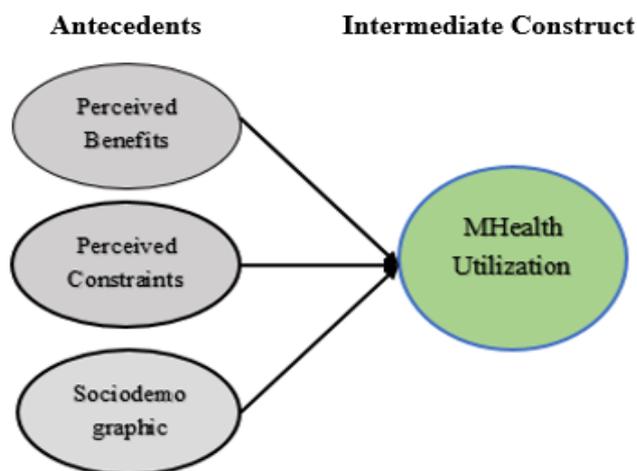


Figure 4.13 Antecedents of MHealth inequalities and the link to MHealth Utilisation

#### 4.4.2. MHealth communication inequalities relate with three antecedents.

The MHealth utilisation inequalities relate with three antecedent factors ((Table 3.29; Figure 3.16) which relate to the following propositions:

P7: Variation in the level of Advocacy in MHealth impacts upon MHealth Interactive Communication Inequalities.

P8: Variation in the level of Social Network in MHealth impacts upon MHealth Interactive Communication.

P9: Variation in the level of Social Support in MHealth impacts upon MHealth Interactive Communication.

The path diagram in Figure 4.14 illustrates the antecedents and how they link to the intermediate factor, MHealth communication.

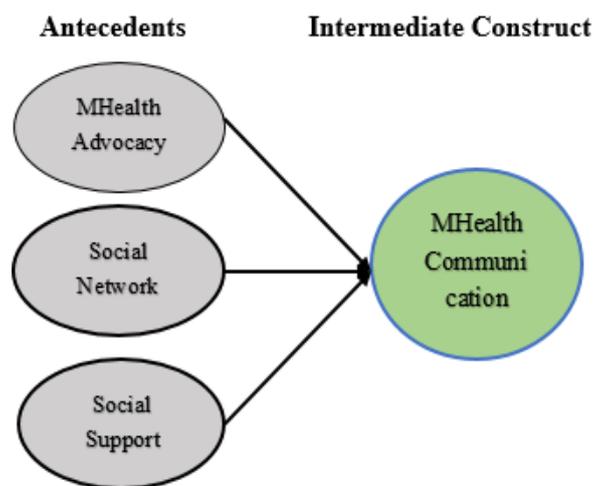


Figure 4.14 Antecedents of MHealth inequalities and the link to MHealth Communication

#### 4.5. Chapter Summary and Conclusion

Chapter 4 presents the findings for the research question 1 which addresses the antecedents of inequalities in consumer MHealth for PAB in the ROI. In addressing question 1, chapter 4 presents the antecedents of consumer MHealth inequalities and traced each antecedent to the corresponding chain of evidence. This chapter presents the nine antecedents which impact consumer MHealth inequalities, comprising of:

- Inequalities due to variations in the level of access to MHealth
- Inequalities due to the variation due to suitability of MHealth equipment
- Inequalities due to variation in autonomy/user control provided by MHealth equipment
- Inequalities due to the variation in users perceived benefits of MHealth
- Inequalities due to variation in user perceived constraints of MHealth
- Inequality due to the variation in demographic and socioeconomic factors
- Inequalities due to the variation in the level of MHealth advocacy
- Inequalities due to the variation in the level of social network in MHealth
- Inequalities due to the variation in the level of social support in MHealth

Validation of the antecedents in the chain of evidence supported the propositions that that three antecedents are linked to one intermediate factor of MHealth inequalities. Chapter 4 developed the following propositions:

P1: Variation in the level of Access to MHealth impacts upon MHealth System Inequalities.

P2: Variation in the level of Suitability of MHealth Equipment impacts upon MHealth System.

P3: Variation in the level of Autonomy of MHealth Equipment impacts upon MHealth System.

P4: Variation in the level of Perceived Benefits of MHealth impacts upon MHealth Utilisation.

P5: Variation in Perceived Constraints of MHealth impacts upon MHealth Utilisation.

P6: Variation in Demographic and Socioeconomic Factors impacts upon MHealth Utilisation.

P7: Variation in the level of Advocacy in MHealth impacts upon MHealth Interactive Communication Inequalities.

P8: Variation in the level of Social Network in MHealth impacts upon MHealth Interactive Communication.

P9: Variation in the level of Social Support in MHealth impacts upon MHealth Interactive Communication.

Validation of the three intermediate constructs and the relationship between the antecedents with the intermediate factors and MHealth inequalities are the subject of research question 2, which is addressed in chapter 5.

## CHAPTER 5.

### MODEL DEVELOPMENT OF MHEALTH INEQUALITIES

#### 5.1 Introduction

This chapter presents the research findings that address research question 2 and focuses on the model development of inequalities in consumer MHealth innovation. The chapter explores the relationship between the antecedents, the intermediate factors, and inequalities in consumer MHealth for the PAB. Section 5.2 restates research question 2 and highlights its relevance in this research. Section 5.3 presents and defines the three intermediate factors of inequalities in consumer MHealth. The section identifies the relationship between the intermediate factors and inequalities in MHealth and provides validation from the chain of evidence grounded in the PAB data. This section shows how the three propositions rely on the validation of the intermediate factors. Furthermore, path diagram is used to establish the connection between the intermediate factors and the MHealth inequalities (section 5.4). The path diagram is further expanded in the section to establish the relationship between the antecedents, the intermediate factors, and the MHealth inequalities. A Venn diagram is also applied to further reveal the interrelationship between all the factors of the MHealth phenomenon. Section 5.6 provides the chapter summary and the conclusion.

#### 5.2 Research Question 2

##### **What are the Relationships Between the Antecedent Factors and Inequalities in Consumer MHealth Innovation for people of African background (PAB)?**

##### **5.2.1 Development of links between factors of MHealth inequalities**

The findings of research question 2 focuses on the conceptualization of the relationship among the factors of inequalities in consumer MHealth (Weiss & Eikemo, 2017). The research model development of how the antecedents of inequalities relate to consumer MHealth provides description and understanding how consumer MHealth innovation aggravates inequalities. The conceptualization of the relationship of the factors of inequalities further decomposes the

MHealth phenomenon into hierarchical orders for ease of understanding (Shahriar Akter et al., 2013; Bagozzi & Yi, 2012; Kenny, 2016; Jeongeun Kim & Park, 2012). The challenges of MHealth inequalities will remain misunderstood and misapplied without resolving the foundational theoretical problems of the relationship among the factors of constructs. The research question 1 addressed the antecedents of inequalities in consumer MHealth (Chapter 4). The model development represents the relationships between factors of inequalities in consumer MHealth.

### 5.2.2 Relationships between the Antecedents and the inequalities in MHealth

This chapter makes use of a path diagram to conceptualise the relationship between the antecedents and consumer MHealth. The path diagram comprises of three-stage model or three-order hierarchical model (Shahriar Akter et al., 2013; Bagozzi & Yi, 2012; Kenny, 2016; Jeongeun Kim & Park, 2012). The three-stages of the hierarchical model comprise of:

- First-order constructs or the antecedents,
- Second-order constructs or the intermediate factors, and
- Third-order constructs or the phenomenon.

Integrating the research findings into a path-diagram discloses that inequalities in consumer MHealth is a formative construct of a third-order hierarchical model. The antecedents connect to the intermediate factors which then impact inequalities in consumer MHealth.

### 5.3 The Intermediate Factors

The antecedents directly link to the intermediate factors comprising of the constructs:

- MHealth System In/equalities
- MHealth Utilisation In/equalities
- MHealth Communication In/equalities

The three intermediate factors are defined in Table 5.1

**Table 5.1 Definition of the three intermediate factors of inequalities in MHealth**

<i>Intermediate Construct</i>	<i>Definition</i>
<b>MHealth system</b>	MHealth system describes a systematic arrangement of people, processes, data and information technology that interact to capture, store, process and communicate to

	provide information to support health service (Istepanian, Laxminarayan, & Pattichis, 2007; Voskarides et al., 2002).
<b>MHealth Utilisation</b>	MHealth Utilisation is conceptualised as the quantification of service used for the purpose for which the technology is made (Carrasquillo, 2013; National Academies of Sciences & Medicine, 2018; Thompson, Higgins, & Howell, 1991). In the case of MHealth for physical activity and fitness [PAF], utilisation is quantified as a measure of time and frequency of moderate to vigorous physical activity [MVPA] or number of steps per day (Health & Children, 2009; Macpherson, Purcell, & Bulley, 2009; Tudor-Locke et al., 2011).
<b>MHealth Communication</b>	MHealth communication is conceptualised as the strategic use of MHealth to inform and influence individuals and those with whom they live, and the larger social networks (community), to enhance health decisions (Christoffel, 2000; Rimal & Lapinski, 2009; Schiavo, 2013).

### 5.3.1 MHealth System Inequalities impacts Consumer MHealth Inequalities

MHealth system inequalities are the variations of three antecedents comprising of the: 1. variation in access to MHealth, 2. variation in Suitability of MHealth equipment and, 3. variation in Autonomy of MHealth equipment. The research findings show that the MHealth system in/equalities is an intermediate factor and a focal construct of the three antecedents.

#### 5.3.1.1 MHealth System

A system is defines a group of interrelated components that function together to achieve a desired result (Benbasat & Zmud, 2003). The MHealth is conceptualised as a transactional information system of people, processes, data and IT (Istepanian, Laxminarayan, & Pattichis, 2007; Voskarides et al., 2002). MHealth is a combination of mobile computer technology (wireless and portable hardware and software) with mobile telecommunication technology (data, image and voice networks) to support health care (Istepanian et al., 2007).

During the research the MHealth information technology was operationalised with technology items which comprised of, 1. internet connection, 2. Smartphone device, 3. Mobile-health software application, 4. Physical activity tracker and 5. Digital weighing scale.

#### 5.3.1.2 Non-Availability of IT Infrastructure

The availability of the infrastructure of the MHealth system was a source of problem for some PAB individuals. During the demographic data collection survey in this research, the PAB individuals who had no internet or smartphone were eventually not considered at all for the

research. The rest of the people who had the basic internet and smartphone were recruited and given additional MHealth devices to participate as part of the research requirement.

#### 5.3.1.3 Lack of awareness of the MHealth

The lack of awareness of the MHealth system was a major disadvantage for PAB individuals. Most PAB individuals did not know about MHealth technology and services. Also, the availability of MHealth has its complexities associated with differences in hardware devices and software apps. The discreet devices which can be added to the health app vary according to the health app which makes the knowledge to be perceived as complicated for the PAB people both in terms of cost, set-up installation requirement and usage.

#### 5.3.1.4 Complexities due to proliferation of MHealth apps and devices

Diversity of health apps comes with uncertainties including decision about unregulated health apps (Dayton, 2014; Wagner, 2020). Also, there are hardware and software management concerns of the complexities of interconnectivity and device synchronisation associated with unregulated health apps and proprietary health devices . Other system administration concerns include what data are collected, how and where these data are managed. Recent studies highlight ongoing efforts to regulate health apps in the EU and in North America (Martínez-Pérez, De La Torre-Díez, & López-Coronado, 2015; Mulder, 2019). What the PAB participants know or what they do not know about MHealth became of the confusion that mitigated against the use of MHealth.

#### 5.3.1.5 Configurational challenges of loosely coupled MHealth Systems

From the citations of the interviews, the TAP and RPD reports of the PAB participants, implied that MHealth system is perceived to be complex for PAB individuals. This complexity was probably for the reason that MHealth systems are loosely coupled and therefore imposed configurational challenges (Henfridsson & Bygstad, 2013). Similarly the MHealth system seems not to be a closely coupled digital infrastructure in terms of its building blocks as well as its functionalities (Henfridsson & Bygstad, 2013).

#### 5.3.1.6 Cost of MHealth disproportionately favours the rich

High production factors of MHealth puts greater demands on PAB resources and disproportionately favours the rich. Therefore, the MHealth was seen as complicated system which therefore raises the health care production factors. High production factors of health disproportionately favours the rich and works as a countervailing mechanism by putting greater

demand on the highly needed resources of PAB population (Chang & Lauderdale, 2009; Goldman & Lakdawalla, 2005). Complications in MHealth innovation can impose greater challenges for some categories of users (Chang & Lauderdale, 2009; Goldman & Lakdawalla, 2005).

### 5.3.2 Citation evidence that MHealth System impacts inequalities in MHealth

Chain of evidence shows that the MHealth System Inequalities impact upon Consumer MHealth Inequalities. Citation evidence is provided to show that the MHealth System Inequalities impact upon Consumer MHealth Inequalities. The citations below are extracts from PAB participant’s interviews, the TAP and RPD reports in which they conceptualised their experiences of the variations in the MHealth System.

**Table 5.2 MHealth System Inequalities impacts Consumer MHealth Inequalities**

<i>P10: MHealth System Inequalities impact upon Consumer MHealth Inequalities</i>	
<i>Variation factor</i>	<i>Participant and the citation evidence</i>
Participant was unable to use the MHealth because he was unaware of MHealth system	<b>Participant 05. CORK 3.1</b> <i>“So, ignorance is majorly, is the main reason. I don't know much about this before this time. So this is my first time of using a mobile fitness or Health app in my life and that's basically the reason”.</i>
The MHealth system was unused due to complexity of set-up and synchronisation	<b>Participant 05. CORK 3.1</b> <i>“Actually, the first time was not too easy because of synchronizing it and the setup. So initially I was having a problem of setting it up and synchronising it.”</i>
The MHealth system was unused because the health app was complicated to use	<b>Participant 06. CORK 3.2</b> <i>“Knowing how to use the app, there is no other problem. You just don't know how to use the app”.</i>
The MHealth system was unused because it required complex involvement	<b>Participant 07. CORK 4.1</b> <i>“...the user interface I don't know how exactly to call it. But if the amount of involvement of the user of the app like it, there are some apps that require more involvement and that can lead to some problems like but the watch in the required you to go to the sleep mode and then activate the sleep mode and then when you're done and you wake up the next morning, you have to turn it off exactly when you wake up which is a problem because people will be tired some nights when going to sleep they will not remember, they're tired”.</i>
Users would not get the MHealth system because it looks costly to purchase	<b>Participant 08. CORK 4.2</b> <i>“I might not use it as much just because I think it's like a little bit more expensive and a lot of people my age probably doesn't, I don't know, have the income for that or have like the time to be spending a lot of money on that”.</i>
MHealth system unused because it required complicated manual operations	<b>Participant 08. CORK 4.2</b> <i>“...they might want it to be more automatic and other people are probably problems with it not being waterproof. So, it accidentally falling and water it can be a problem to people who are usually like surrounded by water washing things who haven't gone swimming, they might forget to take it off and during the shower as well. So, I think those problems are challenges for some people”.</i>

## P10: MHealth System Inequalities impact Consumer MHealth Inequalities

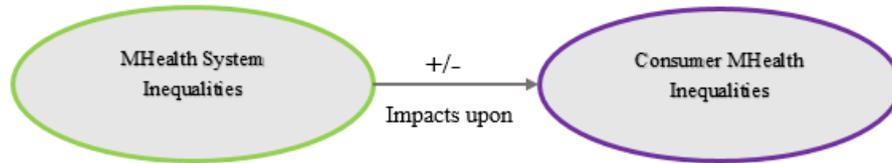


Figure 5.1 MHealth System Inequalities impact Consumer MHealth Inequalities

### 5.3.3 MHealth Utilisation Inequalities impact Inequalities in consumer MHealth

MHealth Utilisation is conceptualised as the quantification of service used for the purpose for which the technology is made (Carrasquillo, 2013; National Academies of Sciences & Medicine, 2018; Thompson et al., 1991). In the case of MHealth for physical activity and fitness, utilisation is quantified as measures of time and frequency of moderate to vigorous physical activity MVPA or number of steps per day (Health & Children, 2009; Macpherson et al., 2009). Utilisation (time and frequency) of MHealth use was determined by perceived benefits, the perceived constraints, and the personal factors such as skills, age and education.

#### 5.3.3.1 MHealth Utilisation Inequalities

MHealth Utilisation inequality is the convergence of the variation of three antecedents comprising of, 1. variation in Perceived Benefits of MHealth, 2. variation in Perceived Constraints of MHealth and, 3. variation in Socio-demographic factors. Therefore, the variation in MHealth Utilisation is the intermediate factor of inequalities in consumer MHealth. The research finding show that the MHealth utilisation in/equalities is an intermediate factor and a focal construct of three antecedents.

The PAB individuals face several challenges to use MHealth due to the lack of social and material resources. PAB participants suffered high demands on their time which put additional pressure on highly needed time for family and work.

#### 5.3.3.2 Citation evidence shows that MHealth utilisation impacts inequalities in MHealth

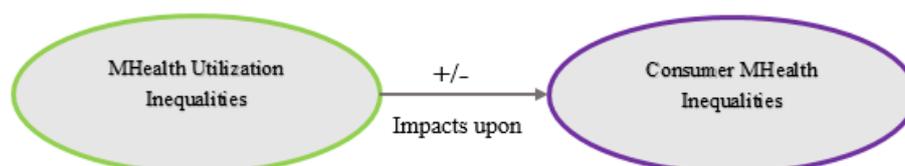
The chain of evidence in Table 5.3 shows that MHealth utilisation inequalities impact upon consumer MHealth inequalities. Citation evidence shows that the MHealth utilisation inequalities impact upon consumer MHealth inequalities. The citations in Table 5.3 are extracts

from PAB participant’s interviews, the TAP/RPD reports in which they conceptualised their experiences of the variations in the MHealth utilisation.

**Table 5.3 MHealth Utilisation Inequalities impact upon Consumer MHealth**

<i>P11- MHealth Utilisation Inequalities impact upon Consumer MHealth Inequalities</i>	
<i>Variation factor</i>	<i>Participant and the citation evidence</i>
Participant could only use MHealth with some technical assistance for lack of skills	<b>Participant 05. CORK 3.1</b> “So, the time factor is the main problem because of the engagement and the children’s activities”.
Participants have no time to use MHealth due to tight schedules	<b>Participant 23. DUBLIN 12.1</b> “The participant received technical assistance from the researcher to complete task steps 16. “From all the devices displayed on screen. Select the weighing scale SBF70), (Health-coach will search for the weighing scale)”. The researcher involvement was needed at this stage to select and connect the mobile phone to the digital weighing scale”.
Participants did not use MHealth due to worries of seeing obese readings	<b>Participant 20 DUBLIN 10.2</b> “I didn't really use it. Because of the way I said, weigh myself often doesn't give me that courage. So, it makes me that I didn't really use this tracker to track my BMI and body mass”.
Participant did not understand the risk of sedentary lifestyle	<b>Participant 04. CORK 2.2</b> “Before this I don't even realize that somebody will stay in bed, you're not sleeping at all. I don't, like before I don't even realize that when I'm not walking, I'm sitting at a place is not good for me. You know, so but when I put this app on, oh my god I only took only 2000 steps a day”.
Participant did not previously understand the risk of sedentary life linked to frequent TV watching	<b>23. DUBLIN 12.1</b> “It does a little bit because as most times I like to sit down watch my [TV] Television, especially the movies, but I'm sacrificing my movie time to just exercise. So, I will say yes”.
Participant has no time to use MHealth due to daily tight routine	<b>Participant 06. CORK 3.2</b> “My daily routine is all over the place, I have so many activities for the day I get to not do my house chores, taking kids to school and going to work. Eventually, some days I could attend church service. So, it's just something that I know that my schedule is very, very tight. But sometimes I managed to put up a few minutes for an exercise”.
Participant could not use MHealth because she found most exercise rigorous	<b>Participant 06. CORK 3.2</b> “I could use the wristband to check my steps, which is one of the easiest one for me to do that even if it's one or two steps At least I do climb from my bedroom to my living room and to my kitchen. So that one I usually do that, but they won't have the other rigorous exercise. I kind of find it difficult to do it because of my time schedule”.
Participant could not use MHealth because she did not initially understand the system	<b>Participant 06. CORK 3.2</b> “I needed someone to explain to me very well about it, but I, I call; how would I say it. I called on the person that introduced it to me, to explain more details. Because it's not something I'm used to. So, and he did explain it very well to the best of my understanding and my knowledge”.

**P11: MHealth Utilisation inequalities impact upon consumer MHealth inequalities**



**Figure 5.2 MHealth Utilisation inequalities impact consumer MHealth inequalities**

### 5.3.4 Communication inequalities impacts Inequalities in consumer MHealth

MHealth communication is conceptualised as the strategic use of MHealth to inform and influence individuals and those with whom they live, and the larger social networks (community), to enhance health decisions (Christoffel, 2000; Rimal & Lapinski, 2009; Schiavo, 2013). MHealth communication is seen to be relevant to various aspects of health and wellbeing, including disease prevention, health promotion, and quality of life improvement (Rimal & Lapinski, 2009; Schiavo, 2013). MHealth communication inequalities for PAB individuals highlight the opportunities lost in combatting inclusiveness through the MHealth interactive network. It is not unusual that MHealth communication agenda escalates action for mainstream population while the problems of minorities wait (Bol, Helberger, & Weert, 2018; Carroll et al., 2017).

#### 5.3.4.1 MHealth communication inequalities

The research findings show that MHealth communication inequality is the convergence of the variation of antecedents comprising of variations in, 1. MHealth advocacy, 2. MHealth social network, and 3. MHealth social support. The research shows that the variation in MHealth communication is an intermediate factor of the inequalities in consumer MHealth.

#### 5.3.4.2 Citation evidence shows, MHealth Communication impacts Inequalities in MHealth.

Chain of evidence shows that the MHealth communication inequalities impact upon consumer MHealth inequalities. The citations in Table 5.4 are extracts from PAB participant’s interviews, the TAP and RPD reports in which they conceptualised their MHealth experiences in Communication.

**Table 5.4 MHealth Interactive Communication Inequalities Impact Consumer MHealth Inequalities**

<i>P12- MHealth Interactive Communication Inequalities impact upon Consumer MHealth Inequalities</i>	
<i>Variation factor</i>	<i>Participant and the citation evidence</i>
PAB participant reports the MHealth Communication and its impact on consumer MHealth in/equalities	<b>06. CORK 3.2</b> <i>“Before now, I don't see any importance of it because you can't know the importance of what you don't know. So now I see the importance of it, how helpful it is to have. How to help you to monitor your health, health levels. Especially how to deal with cardiac health, like exercise helps in cardiac health. The awareness and understanding are better off now than before”.</i>
PAB participant reported MHealth communication involving family members is important for in/equalities in consumer MHealth	<b>08. CORK 4.2</b> <i>“I ended up doing more exercise than I usually would because I was with my family members”</i>

PAB participant believes MHealth communication validation from the national health organisation is a recognition which can improve in/equalities in consumer MHealth	<b>07. CORK 4.1</b> <i>"National Health Service, then that's a big deal. So you'd have to take the word seriously like it's officially recognized like, organization".</i>
PAB participant believes MHealth communication involving a health professional is important to improve in/equalities in consumer MHealth	<b>01. CORK 1.1</b> <i>"Yes, if it's from the health service I'll take it more serious. Because I would take it like it's my prescription that I get from Doctor. So, I'll be more serious about it if the Doctor tells me, see this, do this every day. Do this twice a day, or three times a day. I will try to do what the Doctor tells me, and not to miss any one of it, so that I will get, I will get my health very easily going. But it's not from the Doctor. I wish it's from the Doctor so that it will be more serious, and people will know about it".</i>
PAB participant reported MHealth communication was enlightening for family members and important for in/equalities in consumer MHealth	<b>03. CORK 2.1</b> <i>"[Health] Coach helps us, it helps me, and helps my family too. Especially my wife my children. So, we have known our body fat known how, how we drink water. Know how many steps we take in a day; know how we eat fatty food and all that is we don't know before we have known it. So, it helps us a lot with my family".</i>
PAB participant believes family support for MHealth is important for in/equalities in consumer MHealth	<b>14 GALWAY 7.2</b> <i>"I think maybe there should be the price should be subsidized for families to be able to afford it".</i>
Socially and politically disconnected PAB participant are socially and politically disconnected which impacts upon in/equalities in consumer MHealth	<b>22 DUBLIN 11.2</b> <i>"I never vote before, and I don't really follow. And that's because I don't have interest in politics, and I don't really have time".</i>
MHealth communication support from MHealth professionals would improve in/equalities in consumer MHealth	<b>01. CORK 1.1 TAP and RPD Report</b> <i>"During the think-aloud protocol the participant received technical assistance to select the weighing scale SBF70), (HealthCoach will search for the weighing scale)" and to select and connect the mobile phone health app to the hardware, the digital weighing scale. He also needed help to select the available digital scale, the SBF70 from the HealthCoach display".</i>
MHealth communication within organisations would drive positive change at workplace which is important to in/equality in consumer MHealth	<b>10 GALWAY 5.2</b> <i>"If it's introduced in a company, in drives, it does drive kind of positive changes. People want to exercise more people want to compete a little bit and get good results, and obviously it's good for the health".</i>
MHealth communication will drive positive change within families which impacts upon in/equalities in consumer MHealth	<b>23. DUBLIN 12.1</b> <i>"It helped, and my daughter was also part of this program. Sometimes when she comes back, the first thing she asked is Mommy, did you reach your target? And sometimes, she too, she will not reach her target. So both of us and my son that was not even part of it, they got interest in it so we all we jog up and down and sometimes my husband, you know, it's funny, it's funny I'm like he's joking with me about it. And if you can find in the house is really a good motivator".</i>
MHealth communication provides opportunity to promote PAF guidelines for behaviour change which impacts upon in/equality in consumer MHealth	<b>23. DUBLIN 12.1</b> <i>"It does a little bit because as most times I like to sit down watch my [TV] Television, especially the movies, but I'm sacrificing my movie time to just exercise. So, I will say yes".</i>
MHealth communication provides opportunity to promote PAF guidelines for behaviour change which impacts upon in/equality in consumer MHealth	<b>23. DUBLIN 12.1</b> <i>"It does a little bit because as most times I like to sit down watch my [TV] Television, especially the movies, but I'm sacrificing my movie time to just exercise. So, I will say yes".</i>
Missed opportunity to escalate the use of MHealth to highlight PA guidelines which impacts upon in/equalities in consumer MHealth	<b>23. DUBLIN 12.1</b> <i>"I didn't know about it. I've heard about, I've heard about it, but I've not seen any. And you know what, it's not that I don't have interest, but I have to know about it for me to have interest. So now that I know about it, I have interest in it".</i>

*P12: MHealth Communication inequalities impacts upon consumer MHealth inequalities*

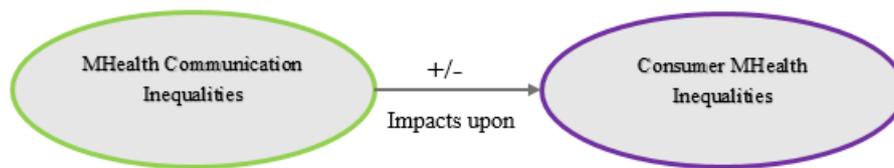


Figure 5.3 MHealth Communication inequalities impact consumer MHealth

## 5.4 Relationship of Antecedents with MHealth Inequalities

The antecedents of inequalities in consumer MHealth link to three intermediate factors encompassing, 1. MHealth system, 2. MHealth utilisation and 3. MHealth communication. The relationship of each the three intermediate factors derive from PAB data and proved in the chain of evidence. The links between the intermediate factors with inequalities in consumer MHealth lead to propositions, P10, P11 and P12.

P10: MHealth System Inequalities impact upon Consumer MHealth Inequalities

P11: MHealth Utilisation Inequalities impact upon Consumer MHealth Inequalities

P12: MHealth Interactive Communication Inequalities impact upon Consumer MHealth Inequalities

### 5.4.1 The Intermediate factors directly impact MHealth inequalities

The research findings show that the intermediate factors directly impact inequalities in consumer MHealth. Therefore, the inequalities in consumer MHealth comprise of variations of three intermediate factors, 1. MHealth System, 2. MHealth utilisation, and 3. MHealth communication. Figure 5.4 is a two-stage path diagram which shows that the links between the intermediate factors and inequalities in consumer MHealth.

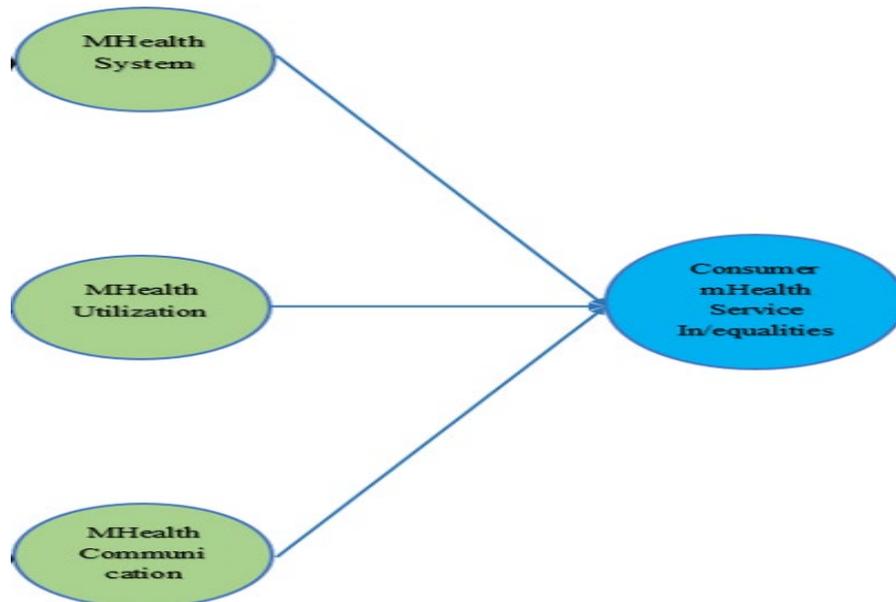


Figure 5.4 Path diagram of intermediate factors and MHealth inequalities

## 5.4.2 MHealth Service Inequalities

The nine constructs of the antecedents of inequalities connect to three intermediate constructs, which impact Inequalities in consumer MHealth.

### 5.4.2.1 The nine antecedents of inequalities in consumer MHealth

The research finding show the antecedents of inequalities in MHealth comprise of the following factors revealed in Chapter 4:

- inequalities due to variations in the level of access to MHealth
- inequalities due to the variation due to suitability of MHealth equipment
- inequalities due to variation in autonomy/user control provided by MHealth equipment
- inequalities due to the variation in users perceived benefits of MHealth
- inequalities due to variation in consumer perceived constraints of MHealth
- inequality due to the variation in demographic and socioeconomic factors
- inequalities due to the variation in the level of MHealth advocacy
- inequalities due to the variation in the level of social network in MHealth
- inequalities due to the variation in the level of social support in MHealth

### 5.4.2.2 Three intermediate factors link with inequalities in consumer MHealth

Consequently, the antecedents are linked to the intermediate factors of inequalities in consumer MHealth. The intermediate factors comprise of three intermediate constructs:

- MHealth System In/equalities
- MHealth Utilisation In/equalities
- MHealth Communication In/equalities

The path diagram in Figure 5.5 shows that inequalities in consumer MHealth is a formative construct of a third-order hierarchical model.

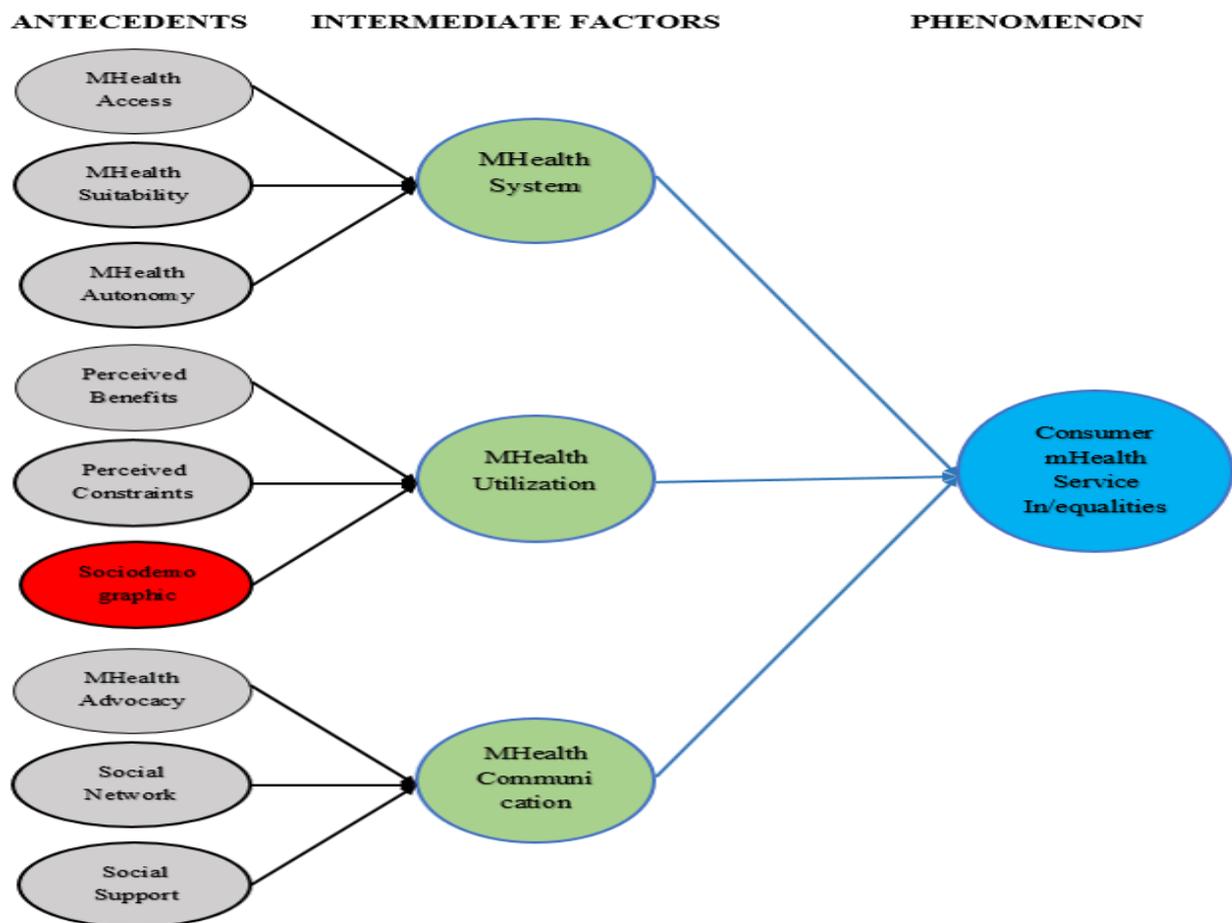
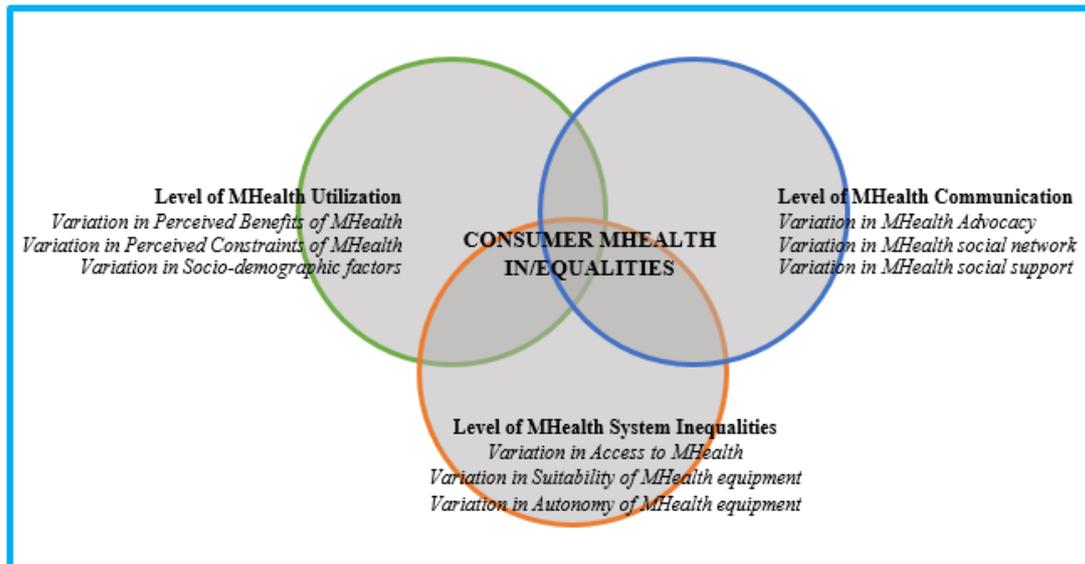


Figure 5.5 Path diagram of factors of MHealth inequalities.

### 5.4.3 Relationships: Antecedents, intermediate factors, and MHealth Inequalities

The nine antecedents connect with the intermediate factors of inequalities in consumer MHealth. Figure 5.6 shows the interconnection of the antecedents with the intermediate factors and the inequalities in consumer MHealth.



**Figure 5.6 Interrelationships between antecedents reveal unknown factors**

The interrelationships between intermediate factors (Figure 5.6) reveal some unknown factors of MHealth inequalities. These factors are not derived in this research and therefore unidentified in Figure 5.6. These unknown factors include the following set of relationships:

- MHealth System interaction with utilisation and with communication.
- MHealth Utilisation interaction with System and with Communication.
- MHealth Communication interaction with System and with Utilisation.

The above three unknown interrelationship factors of MHealth inequalities can be the subjects of further investigation.

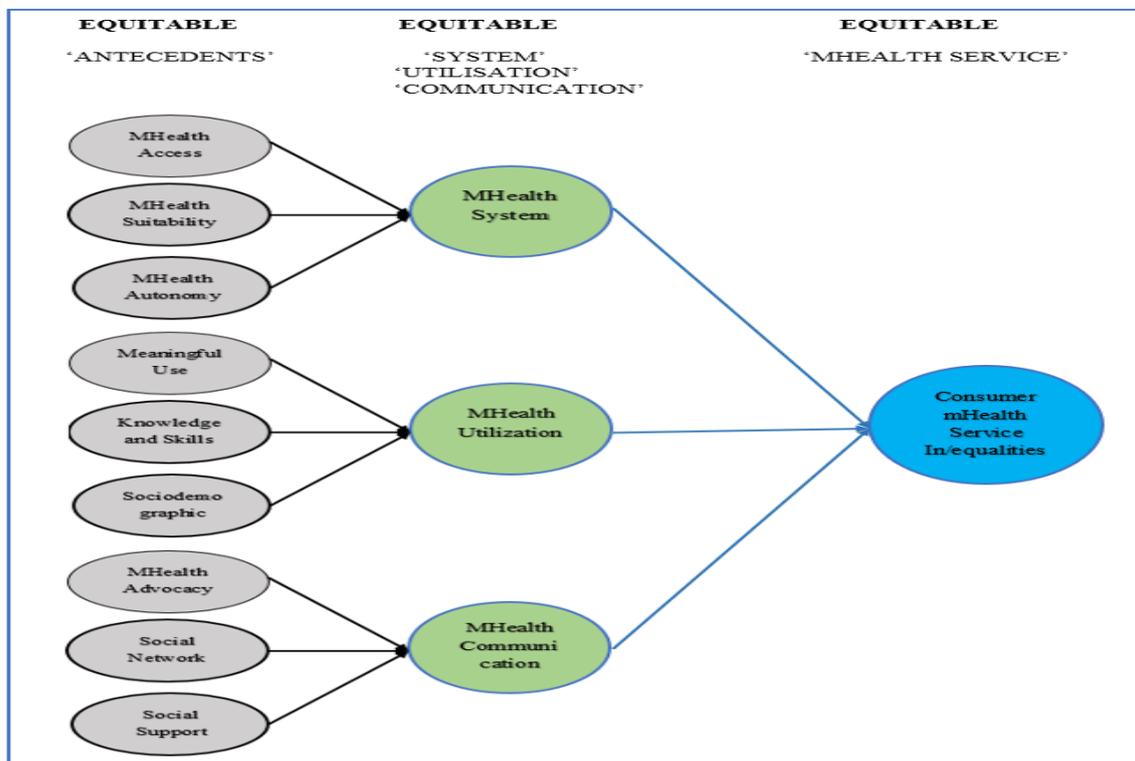
#### **5.4.4 MHealth Equitable Service Model: Mitigating Inequalities in MHealth**

This chapter shows that inequalities comprise of all the antecedent factors of the MHealth ecosystem. Now that we know the antecedents of MHealth inequalities, it is possible to mitigate all these factors within the MHealth ecosystem. Therefore, MHealth service equalities would comprise of the antithesis of the factors of the MHealth service inequalities. The provision of MHealth equitable service requires to counteract the antecedents of MHealth inequalities. By comparison factors of MHealth inequalities are counteracted by factors of MHealth equalities.

**Table 5.5 Comparative antecedents of MHealth in/equalities**

<b>MHealth Inequalities</b>	<b>MHealth Equalities</b>
inequality in access	equality in access
inequality in suitability	equality in suitability
inequality in autonomy	equality in autonomy
inequality in perceived benefits	equality in perceived benefits
inequality in perceived constraint	equality in perceived constraint
inequality in advocacy	equality in advocacy
inequality in social networking	equality in social networking
inequality in social support	equality in social support

MHealth service equalities require equitable factors to mitigate the inequalities in MHealth. MHealth service equalities depend on the provision of MHealth equitable service within the ecosystem to mitigate the factors of MHealth inequalities. Therefore, a model of MHealth equitable service is conceptualised to mitigate inequalities at the three stages of the hierarchical model. Thus, MHealth equitable service (MHES) model is developed from equitable antecedents, equitable system, equitable utilisation, and equitable communication (Figure 5.7).



**Figure 5.7 MHealth Equitable Service Model**

## **5.5 Chapter Summary and Conclusion**

Chapter 5 presents the findings of the grounded data analysis which addresses research question 2. The research findings derived the relationship between the antecedents and the intermediate factors of MHealth inequalities. The intermediate factors represent the links between the antecedents and MHealth inequalities. Chapter 5 explores the relationships between the factors by using path diagrams to delineate the implicit convergence between the antecedents, the intermediate factors, and MHealth inequalities. The chapter demonstrates that nine antecedents connect with three intermediate factors which impact MHealth inequalities. The chapter also conceptualised the MHealth equitable service (MHES) model, by using the equitable factors of the antecedents and the intermediate factors. The MHES model is the equitable version of the MHealth inequalities.

## **CHAPTER 6.**

### **MHEALTH EQUITABLE SERVICE FRAMEWORK**

#### **6.1 Introduction**

Chapter 6 presents the research findings that address research question 3 and focuses on the IS framework we can develop to mitigate inequalities in MHealth for PAB. The chapter starts by restating the research question 3 and highlights its relevance (section 6.2). Section 6.3 introduces the five MHealth ecosystem factors and restates the nine antecedent factors previously derived in chapter 3. Furthermore, the section introduces the MHealth equitable service concept of mitigating inequalities by counteracting the antecedents. The MHES framework leverages a 5 by 9 matrix table to integrate the MHealth ecosystem factors and the antecedents of MHealth inequalities (section 6.4). Section 6.5 evaluates the integration of the factors and analyses how the integration mitigates MHealth inequalities with reference to PAB data. Section 6.6 presents the chapter summary and conclusion of the development of MHESF.

#### **6.2 Research Question 3**

##### **What IS framework can we develop to mitigate inequalities in consumer MHealth innovation for people of African background (PAB)?**

A framework to mitigate inequalities in consumer MHealth provides a useful guide to counteract inequalities during development, implementation, and use of the MHealth innovation. Previous chapters of this research provide the constructs involved in the development of MHealth equitable service (MHES) framework. Fundamentally, MHES framework is developed to mitigate the antecedents of inequalities derived from data analysis in chapter 3. Consequently, chapter 4 provided validation for nine propositions of connecting the antecedents to the intermediate factors. Chapter 5 provided validation for three propositions connecting the intermediate factors to MHealth inequalities.

The IS framework ((chapter 6) shows how equitable MHealth technology can leverage the twelve propositions to mitigate inequalities in MHealth ecosystem. Subsequently, MHealth

researchers, managers and other health information systems' stakeholders can better understand and leverage MHESF to mitigate MHealth inequalities at multilevel.

### **6.3 MHealth Equitable Service Framework**

MHESF is a conceptual framework that takes cognisance of the collective stakeholders' interactions within the MHealth ecosystem. MHESF leverages the multilevel factors of the MHealth ecosystem. The MHESF is conceptualised as an outcome of the stakeholders' interests and activities within the MHealth ecosystem. Studies have leveraged the complex social interactions of the stakeholders to determine system use (Anderson & Aydin, 2005). Behaviour change of individuals has been the focus of MHealth development, however, MHealth ecosystem provide a multilevel approach to address inequalities at various levels .

#### **6.3.1 MHESF is a System Change Framework**

A starting point for this section suggests a critical preview of the existing behavioural change models such as UTAUT by Venkatesh et al. (2003), and other technology acceptance models (Davis, Bagozzi, & Warshaw, 1989; Venkatesh et al., 2003).

Technology acceptance model such as UTAUT is a behavioural model which dominates the MHealth literature. However, UTAUT is focused on technology acceptance by mainstream population without the consideration for equality, diversity, and inclusion of the underserved. Traditionally, technology application is inequitable, and traditionally designed for dominance, a power tool for the mainstream users. Equity invokes notion of fairness and good conscience that are not traditionally considered in acceptance models such as UTAUT. Technology by all ramification is designed to target the majority, not the underserved minorities. The current state of knowledge shows that most of MHealth studies focus exclusively behaviour change models (Marangunić & Granić, 2015; Marcolino et al., 2018).

However, system change advocates argue that individually focused behaviour change frameworks have mainly promoted “victim blaming ideology” by emphasising personal failures in behaviour thereby ignoring the multilevel system that originates and sustains behaviour (McLeroy et al., 1988). Furthermore, system change advocates maintain that little can be achieved by changing individual behaviour without changing social structures and processes within the system that collectively interact to shape the behaviour (Anderson & Aydin, 2005; Iivari et al., 1998). MHESF approach is distinguished from previous approaches

in its integration process that recognises inequalities as the outcome of the multilevel interactions of MHealth stakeholders across the entire environment of the MHealth ecosystem.

### **6.3.2 MHESF Leverages the Multilevel of MHealth Ecosystem**

The sociotechnical environment of the MHealth ecosystem encompass a broad range of factors which include technology, people, organisation, context and policy (Anderson & Aydin, 2005; Iivari et al., 1998; Kaplan, 1997). The sociotechnical environmental factors of the MHealth ecosystem are similitudes of the multiple levels of a social system and the interactions between people and the environment. Ecology based studies identify various components of the environment which they leverage for multilevel frameworks (Bronfenbrenner, 1994; McLeroy et al., 1988). Therefore, MHESF leverages the multilevel environmental factors to address the antecedents of MHealth inequalities at levels of individual, interpersonal, organisational, institutional and public policy (McLeroy et al., 1988).

### **6.3.3 Framework to mitigate inequalities across the MHealth Ecosystem.**

MHESF leverages an integration table as mapping framework to counteract inequalities. MHEF integrates the equitable factors in a matrix table with the MHealth ecosystem factors. Previous studies have leveraged mapping framework as integration platform for IS architecture (Corbin & Strauss, 1990; Zachman, 1987). Similarly, The researcher applied mapping framework as recommended by Similarly Strauss and Corbin (1990) grounded theory analysis proffers integration framework for mapping categories to core categories. Similarly, the MHESF leverages the nine equity factors to counteract the inequalities within the MHealth ecosystem.

### **6.3.4 Counteract the Antecedents of inequalities within MHealth ecosystem**

The sub elements of the IS phenomenon provided the interrogation template during axial coding framework (Chapter 3). The entire coding process involved the analysis that focused on the systematic differences in MHealth innovation for PAB population. The coding template focused on the definition of MHealth IS, as “an arrangement of people, data, processes, and information technology (IT) that interact to collect, process, store and provide as output the information needed to support an organisation” . The MHealth IS definition reveals the sub-elements involved in the stakeholders’ activities which give rise to inequalities across the MHealth ecosystem. The findings of the data analysis developed the antecedents of inequalities in MHealth, and their connection with the intermediate factors.

### **6.3.5 Mitigating Inequalities in MHealth System, Utilisation, Communication**

#### 6.3.5.1 MHESF counteracts the antecedents of inequalities in MHealth

The MHESF is designed to mitigate the inequalities in MHealth by counteracting the antecedents of inequalities in consumer MHealth. Thus, the MHESF integrates equity factors to counteract all the antecedents of MHealth inequalities.

MHESF counteracts MHealth system inequalities caused by the variations in the level of:

- access to MHealth, suitability of MHealth equipment, and autonomy of MHealth equipment

MHSF counteracts MHealth utilisation Inequalities caused by variations in the level of:

- perceived MHealth benefits, perceived MHealth constrains, and sociodemographic factors

MHSF counteracts MHealth communication Inequalities caused by variations in the level of:

- MHealth advocacy, social network in MHealth, and social support in MHealth

#### 6.3.5.2 Stakeholders' activities in MHealth inequalities

The antecedents of MHealth inequalities are conceptualised as the outcome of the stakeholder's interests and activities within the MHealth ecosystem (Anderson & Aydin, 2005; Kaplan, 1997). MHealth system is commonly described in terms of the interaction between hardware, software, networks, data, processes, people, and policies (Wand & Weber, 1990). MHealth stakeholders include non-technical and technical people who have a stake in the delivery and receipt of MHealth service (Eze et al., 2016). MHealth stakeholders include (1) MHealth organisations, (2) MHealth providers, (3) MHealth knowledge workers, and (4) general population who receive healthcare (chapter 2, Figure 2.5). MHealth ecosystem includes the technology, the people and the context of sociotechnical influence (Wand & Weber, 1990).

The stakeholders are organised at various levels of participation in the MHealth ecosystem to include technology, individual, social, organisational, and policy. MHESF leverages equity factors to counteract every antecedent of inequalities in MHealth ecosystem. MHESF systematically map the equity factor to counteract inequalities of all MHealth ecosystem factors. All the antecedents of inequalities in consumer MHealth are targets for equitable substitution.

## 6.4 MHESF and the Equity Matrix

MHESF is organised in a rectangular array or matrix table for the purpose of integration. By leveraging a matrix table, each antecedent of inequalities is replaced by a corresponding equitable factor. The corresponding factors of MHealth in/equalities encompass the equity factors to supplant the antecedents across the sociotechnical environment of the MHealth ecosystem.

### 6.4.1 The sociotechnical environmental factors of the MHealth ecosystem

MHESF conceptualise the stakeholder's activities in the ecosystem into identifiable groups or activity levels (Iyawa et al., 2016; Labrique et al., 2013; Morley & Floridi, 2019; Serbanati et al., 2011). The identifiable groups within the MHealth ecosystem are multiple levels of sociotechnical and ecological environmental factors (Bronfenbrenner, 1994; McLeroy et al., 1988).

#### 6.4.1.1 MHESF integrates equity at the intersection of MHealth ecosystem factors

The MHES framework is developed on a matrix table comprising of nine MHealth equity factors across five MHealth ecosystem factors. The MHESF integrates at the cross points of the matrix table, by placing nine MHealth equity factors on one axis, and placing the five MHealth ecosystem factors on the other axis.

Table 6.6 MHESF matrix of equity across ecosystem multilevel

<i>MHEALTH EQUITY MATRIX</i>									
	Equity in mHealth System			Equity in mHealth Utilization			Equity in mHealth Communication		
	Access	Suitability	Autonomy	Benefits	Constraints	Socio-economic	Advocacy	Social Network	Social Support
<i>Technology</i>									
<i>Individual</i>									
<i>Social</i>									
<i>Organization</i>									
<i>Policy</i>									

Following the table 1, the equity factors are integrated at cross points of the MHESF matrix table to counteract inequalities in MHealth.

#### 6.4.1.2 Equity in MHealth system, MHealth utilisation, and MHealth communication

MHESF is organised under the three intermediate factors of inequalities in MHealth. The three intermediate factors comprise of MHealth system, MHealth utilisation, and MHealth communication. The nine antecedents of inequalities in MHealth are arranged under the three intermediate factors, as the focal construct. All the antecedents of inequalities in consumer MHealth are addressed at different MHealth ecosystem levels, which are technology, individual, interpersonal, organisation and policy.

#### 6.4.1.3 MHESF is contextualized across multilevel of MHealth ecosystem

MHESF counteracts the antecedents of inequalities at various points of the multilevel of MHealth ecosystem. As an analogy, take MHealth as a body with functional organs (elements). As the organs (elements) have become dysfunctional and diagnosed (antecedents). MHESF is developed to integrate or normalise the organs to perform their rightful functions in order to maintain equitable MHealth body. All the organs work normally when each organ of the MHealth body is properly supported to function effectively in equitable way. Therefore, MHESF is developed to support or supplant the antecedents (faulty organs) of the MHealth ecosystem to function in equitable way. Similarly, MHESF integrates equity by counteracting the antecedents of inequalities within the MHealth characteristics (elements) of the hardware, software, and telecommunication networks, data, image, video and voice networks to support equitable MHealth service. MHESF leverages equity factors to provide MHealth access, support MHealth utilisation, and MHealth communication.

### **6.4.2 MHESF integrate equity factors across the MHealth ecosystem**

#### 6.4.2.1 Multilevel MHealth ecosystem factors

The identifiable groups within the MHealth ecosystem are multiple levels of sociotechnical and ecological environmental factors. The MHealth ecosystem multilevel compose of sub elements. MHealth ecosystem multilevel and corresponding sub elements include:

- Technology factors comprise of hardware, software, telecommunication networks).
- Individual factors comprise of knowledge, attitude, behaviour
- Interpersonal factors comprise of family, friends, peers
- Organisational factors comprise of formal/informal structures, processes, guidelines, rules
- Policy factors comprise of policies, laws, regulations

**Table 6.7 Definitions of the MHealth ecosystem multi levels**

MHealth ecosystem multilevel factors and characteristics		
<b>MHealth Technology Level</b>	MHealth technology level refers to technology characteristics (hardware, software, & telecoms data, image, video & voice networks) required to collect, process, store, and provide as output the information needed to support health decision.	(Angst & Agarwal, 2009; Davis et al., 1989; Goldman & Lakdawalla, 2005)
<b>Individual Level</b>	Individual Level refer to the internal and external characteristics of an individual that influence behaviour change, such as knowledge, attitudes, behaviour, self-efficacy, developmental history, gender, age, religion, racial/ethnicity, economic status, financial resources, values, goals, literacy etc.	(Agarwal & Prasad, 1999; McLeroy et al., 1988)
<b>Interpersonal Level</b>	Interpersonal Level refer to the ‘web of social relationships’ that surround specific individuals and those with whom they interact, and the larger community to which the individuals are linked that can influence individual behaviours, including family, friends, peers, co-workers, religious networks, customs or traditions.	(Christoffel, 2000; Glanz, Rimer, & Viswanath, 2008b; McLeroy et al., 1988)
<b>Organisational Level</b>	Organizational Level are characteristics related to culture, structure or management of organisations, work routines and operational rules that affect how, or how well, for example, MHealth innovation are provided to an individual or group.	(McLeroy et al., 1988; Sun & Bhattacharjee, 2011)
<b>Policy Level</b>	Public policy refers to the system of laws, regulatory measures, and courses of action, promulgated by the arms of government or its representatives to allocate resources or establish priorities or promote interest at national, state, Regional, and Local level (in this case concerning MHealth innovation).	(Jarke, 2018; Kilpatrick, 2000; McLeroy et al., 1988; Warkentin & Willison, 2009)

#### 6.4.2.2 MHESF integration of equity factors of the antecedents of inequalities

- **Technology Factors:**

MHESF integrates equity factors to counteract MHealth inequalities at the level of MHealth technology characteristics (hardware, software, and telecommunication data, image, video, and voice networks) for equitable MHealth system

- **Individual Levels:**

MHESF integrates equity factors to counteract MHealth inequalities at the level of individual MHealth user characteristics (knowledge, attitudes, and behaviours) for equitable MHealth service at individual level

- **Interpersonal Levels:**

MHESF integrates equity to counteract MHealth inequalities at the level of interpersonal MHealth user group characteristics (Partners, family, friends, peers) for equitable MHealth system at interpersonal level.

- **Organisational Levels:**

MHESF integrates equity factors to counteract MHealth inequalities at the level of organisational characteristics (operational structures, processes, guidelines/ rules) for equitable MHealth system at organisational level.

- **Public Policy Levels:**

MHESF integrates equity factors to counteract MHealth inequalities at the level of MHealth policy environmental characteristics (local, regional, national enabling laws and policies) for equitable MHealth system at policy level.

MHESF is operationalised in a matrix (Table 6.3), by integrating equity factors of the antecedents of MHealth inequalities across the multilevel of MHealth ecosystem.

**Table 6.8 Integration of equity factors across MHealth ecosystem**

<b>INTEGRATION OF EQUITY FACTORS OF THE ANTECEDENTS OF INEQUALITIES ACROSS THE MHEALTH ECOSYSTEM</b>									
	<b>IN/EQUALITIES IN MHEALTH</b>								
	<b>MHealth System</b>			<b>MHealth Utilisation</b>			<b>MHealth Communication</b>		
<b>MHEALTH ECOSYSTEM</b>	<b>Access</b>	<b>Equipment Suitability</b>	<b>Equipment Autonomy</b>	<b>Perceived Benefits</b>	<b>Perceived Constraints</b>	<b>Social &amp; Demographic</b>	<b>Advocacy</b>	<b>Social Network</b>	<b>Social Support</b>
<b>Technology factors:</b> <i>-hardware, software, &amp; telecoms multimedia networks</i>	equity in access/technology	Equity in Suitability/technology	Equity in autonomy/technology	Equity in perceived Benefits/technology	Equity in Constraints/technology	Equity in Sociodemographic/technology	Equity in Advocacy/technology	Equity in Social Network/technology	Equity in Social Support/technology
<b>Individual factors:</b> <i>-psychological: knowledge, attitude, behaviour</i>	equity in access/Individual	Equity in Suitability/Individual	Equity in autonomy/Individual	Equity in perceived Benefits/Individual	Equity in Constraints/Individual	Equity in Sociodemographic/Individual	Equity in Advocacy/Individual	Equity in Social Network/Individual	Equity in Social Support/Individual

<b>Interpersonal factors:</b> -psycho-social: Partners, family, friends, peers	equity in access/ Interpersonal	Equity in Suitability/ Interpersonal	Equity in autonomy/ Interpersonal	Equity in perceived Benefits/Interpersonal	Equity in Constraints/Interpersonal	Equity in Sociodemographic/Interpersonal	Equity in Advocacy/Interpersonal	Equity in Social Network/Interpersonal	Equity in Social Support/Interpersonal
<b>Organisation factors:</b> -operational structures, processes, guidelines, rules	equity in access/ Organisation	Equity in Suitability/ Organisation	Equity in autonomy/ Organisation	Equity in perceived Benefits/Organisation	Equity in Constraints/Organisation	Equity in Sociodemographic/Organisation	Equity in Advocacy/Organisation	Equity in Social Network/Organisation	Equity in Social Support/Organisation
<b>Policy factors:</b> -local, regional, national enabling environment: laws & policies	equity in access/ Policy	Equity in Suitability/ Policy	Equity in autonomy/ into policy	Equity in perceived Benefits/policy	Equity in Constraints/policy	Equity in Sociodemographic/policy	Equity in Advocacy/ policy	Equity in Social Network/ policy	Equity in Social Support/ policy

## 6.5 MHESF and PAB

This section evaluates the integration of equitable factors and analyses how the integration mitigates MHealth inequalities and how they relate to PAB data. MHESF integrates equity at the intersection of the MHealth ecosystem factors and the antecedents of inequalities in MHealth. Antecedents of MHealth inequalities are represented on the horizontal axis, while the MHealth ecosystem factors are represented on the vertical (Table 6.3, Table 6.4). It is important to note that the positioning of the factors along the horizontal or vertical axis is a matter of convenience, and not a fixed rule. Therefore, either the MHealth equity factors or the MHealth ecosystem can be placed on the horizontal axis, and vice versa (Table 6.3; Table 6.4). Thus, the table serves for the integration of MHealth equity factors at all levels of MHealth ecosystem. The MHealth equity factors are the direct antithesis of the antecedents of inequalities in MHealth. All antecedents and multilevel of MHealth ecosystem are represented in the matrix of MHESF (Table 6.7).

### 6.5.1 Equitable MHealth System: Access, Suitability, Autonomy of IT

#### 6.5.1.1 Equity across MHealth access, suitability, and autonomy of IT equipment

MHESF addresses equity in MHealth systems for PAB population focusing on MHealth access, suitability, and autonomy of MHealth equipment. The MHES framework addresses equity in access for PAB in terms of availability, awareness, interest, ownership of software, hardware, and internet connection (chapter 4, section 4.3.1). MHESF addresses equity in the suitability

of equipment for PAB in terms of quality, functionality, in/compatibility, standardization of proprietary devices, legacy systems, inter and intra-operability of devices, network speed and software limitations (chapter 4, section 4.3.2). Furthermore, MHESF addresses equity in the autonomy of the MHealth equipment for PAB in terms of de/centralized control of equipment, time-regulated services, un/automated functionalities, and other user restrictions of IT equipment and resources. The factors of inequalities and the potential remedies are implicated in the expressions of the PAB (chapter 4, section 4.3.3).

#### 6.5.1.2 PAB challenges in terms of MHealth access, suitability, and autonomy equipment

The current situation according to research findings show the lack of availability, lack of awareness, and lack of ownership of MHealth for PAB individuals (chapter 4, section 4.3). During the interview(chapter 4, table 4.4), the PAB participant were asked the reason for not using MHealth; the reply was:

*Well...this one came easy, it was free. Which means if health can be made accessible to people and make cheap enough it will encourage a lot of people to get into it. So, for me, ...because it was free, it didn't cost me anything (Participant 21 DUBLIN 11.1).*

#### 6.5.1.3 MHESF remedy for MHealth access, suitability, and autonomy of IT equipment

The research findings show that PAB populations were never considered as target focus for the design and manufacture of consumer MHealth devices. MHESF is developed to incorporate equity characteristics at design and implementation stages. Inclusiveness of the PAB individuals incorporate their characteristics in terms of knowledge, skills and behaviour including their lifestyle, and cultural nuances. Similarly, the MHESF offers opportunity for awareness and interest through social interactions of family, friends, and peers. The MHESF enables awareness and motivation of PAB participants through family and groups discussions on MHealth service. Encouraging the use of MHealth service in families, during the interviews (Table 4.4), the PAB participant said:

*It was good, with my husband, sometimes we will discuss who did what and how many steps you've done. I guess the more family members are involved, the better. We can then all kind of compete and see who's done more. We use something similar... at work and it's very encouraging. And translating it into competition encourages people to do better and to do more (Participant 10 GALWAY 5.2).*

Similarly, organisational characteristics offers opportunities for the MHSF to address equity in MHealth access, suitability, and autonomy of IT equipment. Government and health organisation agencies can provide material and social incentives to support PAB and other

minorities and to promote awareness and skills in MHealth. Organisations can work with health professionals who have the knowledge and skills to support individuals and families for equitable MHealth. Organisational agencies can be empowered to monitor and have oversight of MHealth equipment and activities at local, regional, and national levels.

Furthermore, policy frameworks offer enabling environment through laws, policies, and guidelines of local, regional, national government to support MHealth equity for PAB and other minority populations. Especially, equity in suitability and autonomy and control can be addressed by creating enabling laws, regulations, policies, and guidelines to support MHealth services. MHESF focusing on the MHealth system and addressing MHealth access, suitability and autonomy is presented in Table 6.4. All antecedents and multilevel of MHealth ecosystem are represented in the matrix of MHESF (Table 6.7).

**Table 6.9 MHESF: Focus on MHealth system for access, suitability, and autonomy**

IN/EQUALITIES IN MHEALTH	MHEALTH TECHNOLOGY	IN/EQUALITIES IN THE 'MHEALTH IS' ECOSYSTEM			
		Individual Level: psychological: knowledge, attitude, behaviour	Interpersonal Level: psycho-social: Partners, family, friends, peers	Organisational Level: operational structures, processes, guidelines, rules	Policy Level: local, regional, national enabling environment: laws & policies
<b>Antecedents of MHealth In/equalities [for physical activities &amp; fitness]</b>	<b>MHealth Technology Level:</b> (hardware, software, & telecoms multimedia networks)				
<b>MHealth System In/equalities</b>	MHealth System In/equalities	<b>MHealth System In/equalities</b>	MHealth System In/equalities	<b>MHealth System In/equalities</b>	MHealth System In/equalities
• due to the variation in the level of 'Access to MHealth'	integrate equity factors of the antecedents of in/equalities into MHealth technology for equitable MHealth access	integrate equity factors of the antecedents of in/equalities into individual MHealth user for equitable access to MHealth	integrate equity factors of the antecedents of in/equalities into interpersonal MHealth user group for equitable access to MHealth	integrate equity factors of the antecedents of in/equalities into MHealth organisation for equitable access to MHealth	integrate equity factors of the antecedents of in/equalities into MHealth policy environment for equitable access to MHealth
• due to the variation in the level of 'Suitability of MHealth Equipment'	integrate equity factors of the antecedents of in/equalities into MHealth technology for equitable MHealth equipment	integrate equity factors of the antecedents of in/equalities into individual MHealth user for equitable suitability for MHealth equipment	integrate equity factors of the antecedents of in/equalities into interpersonal MHealth user group for equitable suitability of MHealth equipment	integrate equity factors of the antecedents of in/equalities into MHealth organisation for equitable suitable of MHealth equipment	integrate equity factors of the antecedents of in/equalities into MHealth policy environment for equitable suitability of MHealth equipment
• due to the variation in the level of Autonomy of MHealth Equipment	integrate equity factors of the antecedents of in/equalities into MHealth technology for equitable autonomy of MHealth equipment	integrate equity factors of the antecedents of in/equalities into individual MHealth user for equitable autonomy of MHealth Equipment	integrate equity factors of the antecedents of in/equalities into interpersonal MHealth user group for equitable autonomy of MHealth Equipment	integrate equity factors of the antecedents of in/equalities into MHealth organisation for equitable autonomy of MHealth Equipment	integrate equity factors of the antecedents of in/equalities into MHealth policy environment to support healthcare through equitable autonomy of MHealth Equipment

## 6.5.2 Equitable MHealth Utilisation: Benefits, Constraints, and Demographics

### 6.5.2.1 Equity in MHealth utilisation, perceived benefits, constraints, and demographics

MHESF addresses equity in MHealth utilisation for PAB population in terms of perceived benefits, perceived constraints, and demographic characteristics of PAB population. MHESF integrates equity into perceived benefits for PAB to address the level to which PAB population believe that using MHealth would enhance their PAF performance to capture, store, organise, and communicate information. MHESF also integrates equity to address perceived barriers or inhibitions associated with demotivation due to difficulties with equipment, personal challenges, personal bias, lack of skills, limited time, and environmental difficulties affecting the use of MHealth. Furthermore, MHESF addresses challenges due to demographic characteristics of PAB in terms of gender, age, health status, education, employment, income location, and complexities arising from minority and ethnicity. The factors of inequalities and the potential remedies are implicated in the expressions of the PAB.

### 6.5.2.2 PAB challenges of perceived benefits, perceived onstraints and demographic factors

The PAB individuals showed no previous perception of the benefits of the MHealth. Therefore, the PAB participants did not have any previou knowledge of the usefulness of MHealth, nor believe that using MHealth would enhance their PAF performance. Some of the PAB participants said they thought that the MHealth PAF were not useful. However, the research findings show that during the TAP and RPD protocols, the PAB participants could tell the immense benefits of the MHealth PAF. Describing the perceived benefits of MHealth during the interview (Appendix M), the PAB participant said:

*When I started, my BMI was ... yellowish. My body fat was red. My water was between yellow and red. Then my muscle was yellow and ...green. But now my muscle is green. My water level green, my body fats is Yellow, strong green, .... Then BMI is green. A very big, massive improvement (Participant 04. CORK 2.2).*

Similarly, during the interview (Appendix M) another PAB participant said:

*It was really good if you just want to quickly look at something and know whether it's increasing or decreasing self-checking numbers and crunching facts you just look at a chart and it shows a graph that says clearly increasing. That was that was really useful (Participant 07. CORK 4.1).*

Conversely, the PAB participants expressed their constraints of the MHealth in terms of the complexity and the degree to which using the MHealth was perceived as being difficult and demotivating. A PAB participant was so concerned about the experience of “Ostrich Problem”;

a situation where seeing unhealthy weight outcome caused discouragement rather than encouragement. The participant said:

*“... when I weigh myself often it makes me to really have a bad day and I stopped. You know because it doesn't really give me what I want. So, I stopped...”* (Appendix M, Participant 20 DUBLIN 10.2).

Similarly, the demographic and socioeconomic factors of the PAB participants contributed to inequalities in the use of MHealth. The sociodemographic disadvantages of the PAB are associated to factors such as age, education, employment, income, location, race, and culture (chapter 3, section 3.9.1). The PAB highlighted factors related to racial profiling, stereotyping, distrust of medical professionals, unfamiliarity with people and the lack of specialists from African populations, language barriers and cultural barriers, including high cost of MHealth devices. During the interview, when asked about MHealth cost, the PAB said:

*Well, I would say the first thing is this one came easy, it was free. Which means if health can be made accessible to people and make cheap enough it will encourage A lot of people to get into it. So, for me, I have never considered any app to be able to help me to improve my lifestyle until I came in touch with this. And because it was free, it didn't cost me anything* (Appendix M, Participant 23. DUBLIN 12.1).

All these factors affected the utilisation of the MHealth for the PAB participants. Therefore, the perceived benefits, perceived barriers, and the socio-demographic characteristics of the PAB participants affected the utilisation of the consumer MHealth.

#### 6.5.2.3 MHESF equity for perceived benefits, perceived constraints and demographics

MHESF integrates equity to address the utilisation for PAB population in terms of perceived benefits, perceived constraints, and demographic characteristics. The individual characteristics offer opportunities in terms of knowledge, attitude, skills, and behaviour to address perceived benefits, perceived constraints, and demographic characteristics. Notably, individually focused programmes target the change of knowledge, skills and behaviour towards the MHealth. Change factors can also be channeled to address problems arising from PAB characteristics, such as gender, or age related problems. Similarly, MHESF integrates equity into interpersonal characteristics by taking advantage of opportunities within families, friends and peer groups to promote the benefits of MHealth services and address limitations imposed by constraints and socio-demographic impediments. Furthermore, organisational factors and policy frameworks offer opportunities to address equity in perceived benefits of MHealth, as well as the limitations imposed by perceived constraints and demographic factors of PAB population. The MHESF is presented in Table 6.5, focusing on the MHealth utilisation and addressing perceived benefits,

perceived constraints, and socio-demographic factors. All antecedents and multilevel of MHealth ecosystem are represented in the matrix of MHESF (Table 6.7).

**Table 6.10 MHESF of MHealth utilisation for perceived benefits, constraints, and demographics**

IN/EQUALITIES IN MHEALTH	MHEALTH TECHNOLOGY	IN/EQUALITIES IN THE 'MHEALTH IS' ECOSYSTEM			
		Individual Level: psychological: knowledge, attitude, behaviour	Interpersonal Level: psycho-social: Partners, family, friends, peers	Organisational Level: operational structures, processes, guidelines, rules	Policy Level: local, regional, national enabling environment: laws & policies
<b>Antecedents of MHealth In/equalities [for physical activities &amp; fitness]</b>	<b>MHealth Technology Level:</b> (hardware, software, & telecoms multimedia networks)				
<b>MHealth Utilisation In/equalities</b>	MHealth Utilisation In/equalities	MHealth Utilisation In/equalities	MHealth Utilisation In/equalities	MHealth Utilisation In/equalities	MHealth Utilisation In/equalities
• due to the variation in the level of 'Perceived Benefits of MHealth	integrate equity factors of the antecedents of in/equalities into MHealth technology for equitable benefits of MHealth in MHealth utilisation	integrate equity factors of the antecedents of in/equalities into individual MHealth user for equitable benefits in MHealth utilisation	integrate equity factors of the antecedents of in/equalities into interpersonal MHealth user group for equitable benefits of MHealth utilisation	integrate equity factors of the antecedents of in/equalities into MHealth organisation for equitable benefits of MHealth utilisation	integrate equity factors of the antecedents of in/equalities into MHealth policy environment for equitable benefits of MHealth utilisation
• due to the variation in the level of 'Perceived Constraints of MHealth	integrate equity factors of the antecedents of in/equalities into MHealth technology for equitable MHealth utilisation without constraints	integrate equity factors of the antecedents of in/equalities into individual MHealth user for equitable MHealth utilisation without constraints	integrate equity factors of the antecedents of in/equalities into interpersonal MHealth user group for equitable benefits of MHealth utilisation	integrate equity factors of the antecedents of in/equalities into MHealth organisation for equitable MHealth utilisation without constraints	integrate equity factors of the antecedents of in/equalities into MHealth policy environment for equitable MHealth utilisation without constraints
• due to the variation in the Demographic and Socioeconomic Factors	integrate equity factors of the antecedents of in/equalities into MHealth technology for equitable MHealth utilisation at for low socio-economic barriers	integrate equity factors of the antecedents of in/equalities into individual MHealth user for equitable MHealth utilisation for low socio-economic status	integrate equity factors of the antecedents of in/equalities into interpersonal MHealth user group for equitable MHealth utilisation for low socio-economic status	integrate equity factors of the antecedents of in/equalities into MHealth organisation for equitable MHealth utilisation for low socio-economic status	integrate equity factors of the antecedents of in/equalities into MHealth policy environment for equitable MHealth utilisation for low socio-economic status

### 6.5.3 Equitable Communication: Advocacy, Social Networks, Social supports

#### 6.5.3.1 Equity in advocacy, social networks, and social support

MHESF addresses equity in MHealth communication for PAB population in their limitations imposed by advocacy, social networks, and social support. MHESF integrates equity to derive advocacy for PAB and to address shortcomings in the strategic use of information for public enlightenment and promotion. MHESF integrates social networks to address the limited web

of social relationships of family, friends, peers, cultural and community groupings of the PAB population. Furthermore, MHESF integrates equity into social support to address the lack of social influence, companionship, and support to individuals, and families of PAB population.

#### 6.5.3.2 PAB challenges in terms of advocacy, social networks and social support.

The PAB population expressed their experiences of the inequalities imposed by limitations in interactive MHealth communication, and the lack of advocacy, as well as the limitation of social networks and social supports. Despite the popularity of mobile health devices, it was surprising that some PAB participants were not conversant with MHealth or did not use the devices as expected. During the interview, the PAB participant was asked the reason for not previously using any mobile health app. The PAB replied:

*Ignorance, so many people aren't aware of, of such app. So many people are not aware that they could, you know, be able to help themselves from their comfort zone. So, if people will be aware of it, I think it will help so much (Appendix M, Participant 05. CORK 3.1).*

Another PAB participant stated:

*Apps? I just didn't know that much about them. And they seemed like expensive, and that it didn't help that much. And I didn't really understand how it worked and things but now that I'm using it, I think it's a good app (Appendix M, Participant 02. CORK 1.2).*

The above statements and many other comments of the PAB participants demonstrate complete lack of communication, and indicate shortcomings in MHealth advocacy and isolation from strategic use of information for public enlightenment and promotion. The PAB participants also experienced limitations in terms of social networks and support. The research findings also show that PAB participants belong to minorities of African background, and living in isolated patches among the mainstream population. Findings show that PAB population have limited network of families, friends and community contacts to relate with in the ROI. They relied on “Whatsapp” for free international calls, as well as the communication with the researcher during the eight weeks MHealth usage period. The limitations imposed by social networks also translate to unfamiliarity with the society and limitation in economic participation and political relevance. Furthermore, PAB population is limited in terms of social influence, companionship, and support to individuals, and families. PAB participants expressed their limitations imposed by MHealth communication, and the lack of advocacy, thus:

*“Because nobody has told me about any mobile app or Health app or whatever, until you introduced it. And honestly, that's the best thing” (Appendix M, Participant 16 GALWAY 8.2).*

During the interview, the PAB participant say they would take the MHealth more seriously if it was approved by the national health service provider.

*Yes, if it's from the health service I'll take it more serious. Because I would take it like it's my prescription that I get from Doctor. So I'll be more serious about it if the Doctor tells me, see this, do this every day. Do this twice a day, or three times a day. I will try to do what the Doctor tells me, and not to miss any one of it, so that I will get, I will get my health very easily going. But it's not from the Doctor (Appendix M, Participant 01. CORK 1.1).*

In a reply to one of the research questions (Appendix G), another PAB said:

*"If it's recommended by the National Health Service, then that's a big deal. So you'd have to take the word seriously like it's officially recognized like, organization" (Participant 07. CORK 4.1).*

MHESF integrates equity to address the inequalities in communication caused by limitations in advocacy, social network and social support at the various levels of the MHealth ecosystem.

### 6.5.3.3 MHESF equity for advocacy, social network, and social support

MHESF offers opportunities at the organisational and policy levels to address inequalities imposed by limitations in interactive MHealth communication. Through organisational processes and policy frameworks the MHESF integrates equity to address shortcomings in the strategic use of information for public enlightenment and promotion, which can provide social and material support for individuals, families, and community groupings of the PAB population. MHESF focuses on the MHealth communication and addresses MHealth advocacy, social network, and social support. Table 6.6 represents the matrix of equity factors integrated for antecedents of inequalities in MHealth system, MHealth utilisation, and MHealth communication. All antecedents and multilevel of MHealth ecosystem are represented in the matrix of MHESF (Table 6.7).

**Table 6.11 MHESF of MHealth communication, advocacy, social network, and social support**

INEQUALITIES IN MHEALTH	MHEALTH TECHNOLOGY	INEQUALITIES IN THE 'MHEALTH IS' ECOSYSTEM			
		Individual Level:	Interpersonal Level:	Organisational Level:	Policy Level:
Antecedents of MHealth In/equalities [for physical activities & fitness]	MHealth Technology Level: (hardware, software, & telecoms multimedia networks)	psychological: knowledge, attitude, behaviour	psycho-social: Partners, family, friends, peers	operational structures, processes, guidelines, rules	local, regional, national enabling environment: laws & policies
MHealth Communication In/equalities	MHealth Communication in/equalities	MHealth Communication In/equalities	MHealth Communication in/equalities	MHealth Communication In/equalities	MHealth Communication In/equalities

<ul style="list-style-type: none"> <li>• due to the variation in the level of 'MHealth Advocacy</li> </ul>	integrate equity factors of the antecedents of in/equalities into MHealth technology for equitable MHealth advocacy through MHealth communication	integrate equity factors of the antecedents of in/equalities into individual MHealth user for equitable MHealth advocacy through MHealth communication	integrate equity factors of the antecedents of in/equalities into interpersonal MHealth user group for equitable advocacy through MHealth communication	integrate equity factors of the antecedents of in/equalities into MHealth organisation for equitable advocacy of MHealth through MHealth communication	integrate equity factors of the antecedents of in/equalities into MHealth policy environment for equitable advocacy of MHealth through communication
<ul style="list-style-type: none"> <li>• due to the variation in the level of 'Social Network in MHealth</li> </ul>	integrate equity factors of the antecedents of in/equalities into MHealth technology for equitable MHealth social network for communication	integrate equity factors of the antecedents of in/equalities into individual MHealth user for equitable social network in MHealth	integrate equity factors of the antecedents of in/equalities into interpersonal MHealth user group for equitable MHealth social network for communication	integrate equity factors of the antecedents of in/equalities into MHealth organisation for equitable MHealth social support in MHealth through communication	integrate equity factors of the antecedents of in/equalities into MHealth policy environment for equitable MHealth social support through communication
<ul style="list-style-type: none"> <li>• due to the variation in the level of 'Social and Material Support</li> </ul>	integrate equity factors of the antecedents of in/equalities into MHealth technology for equitable MHealth social support	integrate equity factors of the antecedents of in/equalities into individual MHealth user for equitable social support in MHealth	integrate equity factors of the antecedents of in/equalities into interpersonal MHealth user group for equitable social support through MHealth communication	integrate equity factors of the antecedents of in/equalities into MHealth organisation for equitable MHealth social support through communication	integrate equity factors of the antecedents of in/equalities into MHealth policy environment for equitable social support in MHealth

Table 6.12 MHESF to mitigates antecedents of MHealth inequalities of system, utilisation, and communication

		mHealth system			mHealth utilization			mHealth communication		
MHealth Ecosystem	important sources of influence	Access ° availability, awareness, interest, ownership of software, hardware & internet	Suitability ° functional competence, features, standards, quality, compatibility, interoperability of software, hardware, internet	Autonomy ° users control de/centralized, time regulated, automated functionalities & restriction of resources	Perceived Benefits ° capture, store, organise, communicate information, Reminders, motivational rating, journaling, BMI guideline charts	Perceived Constraints ° difficulties with equipment, personal challenges, bias, lack of skills & inefficacy, time, family or work pressure, difficult environment	Demographic Profile ° gender, age, health status, education, employment, income location, population group	Advocacy ° strategic use of information for public enlightenment & promotion	Social Network ° web of social relationships of family, friends, peers, community	Social Support ° social influence, companionship, & support to individuals, families, groups
Technology innovation of	° hardware ° software ° communication networks									
Incentivise/ enable individuals to improve	° knowledge ° attitude ° skills ° behaviour									
Leverage interpersonal opportunities	° family ° friends ° peers									
Organisations for promotional campaigns & Support	° structures ° processes ° work groups ° professionalism									
Create positive environment	° regulations ° policies ° guidelines									

## **6.6 Chapter Summary and Conclusion**

Chapter 6 addresses the research question 3 by developing MHESF to mitigate inequalities in consumer MHealth innovation for PAB. MHESF represents the integration of equity factors across multilevel MHealth ecosystem factors. MHESF integrates equitable factors to counteract the antecedents across the multilevel of MHealth ecosystem (technology, individual, interpersonal, organisational, and policy) factors. Thus, MHESF counteracts all the antecedents of MHealth inequalities. MHESF integrates equity factors to antecedents of inequalities in MHealth to derive equity in MHealth system (access, suitability, autonomy); equity in MHealth utilisation (perceived benefits, perceived constraints, demographic factors); and equity in MHealth communication (advocacy, social network, social support). All antecedents and multilevel of MHealth ecosystem are represented in the matrix of MHESF (Table 6.7).

## **CHAPTER 7.**

### **DISCUSSION AND CONCLUSION**

#### **7.1 Introduction**

Chapter 7 draws on previous chapters for a concise discussion of the research findings, and to highlight the contributions of this study. It also presents the concluding remarks for the study. The chapter begins with a restatement of the research objective and research questions (section 7.2) and presents a summary of the methodology used to address the questions. Section 7.3 teases out the study findings for research questions 1, 2 and 3. Section 7.4, summarises the research study contributions. Section 7.5 discusses the implications of the research findings, and section 7.6 presents the potential limitations. Section 7.7 presents the summary and conclusion of the major achievements of this research.

#### **7.2 Research Objective and Research Methodology**

##### **7.2.1 Research objective**

The research objective explores the antecedents of inequalities in consumer MHealth innovation for PAB in the ROI and develops IS framework to mitigate MHealth inequalities. The research objective gives rise to three research questions (chapter 2). Chapter 4 addresses research question 1 and explores the antecedents of inequalities in consumer MHealth innovation for the PAB. Chapter 5 addresses research question 2 and develops the relationship between the antecedent factors and inequalities in consumer MHealth innovation for PAB. Chapter 6 addresses research question 3 and develops IS framework to mitigate inequalities in consumer MHealth innovation for PAB. The research objective and research questions are the starting point in the following discussion of the methodology applied (section 7.2.2).

##### **7.2.2 Chapter 3: Research Methodology**

The methodology chapter restates the research objective and research questions which ensured adoption of suitable research design. The study adopted the interpretivist paradigm with qualitative research design and multiple case study method that captures the in-depth account of naturalistic and contemporary events for theory building. The research study was conducted

in the ROI, in the period between July 2019 and March 2020. Twenty-four individuals from twelve households of minorities of PAB participated in the data collection. Quantitative and qualitative data were collected from multiple sources to ensure data triangulation. Quantitative analysis was conducted with the demographic data. Qualitative data analysis was conducted by concurrently using NVivo QDAS, and by following the grounded theory methodology espoused by Strauss and Corbin (1990). The three-stage data coding resulted to the development of categories (antecedents), and core-categories (intermediate factors) which propose a reasonable theory for understanding inequalities in consumer MHealth. Section 7.3 presents teases out the discussion of the research findings.

### **7.3 Discussion of the Research Findings**

This section summarises the research findings from previous chapters. Discussion of the research findings draw from chapters 4 for research question 1, chapter 5 for research question 2 and chapter 6 for research question 3.

#### **7.3.1 Antecedents of inequalities in consumer MHealth**

Chapter 4 addresses question 1 by disentangling the nine antecedents of MHealth inequalities. Previous studies argue that MHealth inequalities is a derivative of low socioeconomic status, however, chapter 4 shows the nine antecedents which impact MHealth inequalities. Thus, low socioeconomic status is just one out of the nine antecedents of MHealth inequalities.

Chapter 4 provides the chain of evidence for the nine antecedents of MHealth inequalities which comprise of the following factors:

- Inequalities due to variations in the level of access to MHealth
- Inequalities due to the variation due to suitability of MHealth equipment
- Inequalities due to variation in autonomy/user control provided by MHealth equipment
- Inequalities due to the variation in users perceived benefits of MHealth
- Inequalities due to variation in user perceived constraints of MHealth
- Inequality due to the variation in demographic and socioeconomic factors
- Inequalities due to the variation in the level of MHealth advocacy
- Inequalities due to the variation in the level of social network in MHealth
- Inequalities due to the variation in the level of social support in MHealth

This study shows that antecedents directly impact the intermediate factors of MHealth inequalities.

### **7.3.2 Three antecedents directly impact each intermediate factor of MHealth**

Furthermore, there are three intermediate factors which serve as the intermediary between the antecedents and MHealth inequalities. The propositions outline the antecedents which impact the intermediate factors which in turn impact MHealth inequalities. Thus, the antecedents directly impact the intermediate factors which then directly impact MHealth inequalities. Three antecedents impact each intermediate factor as outlined below.

#### **MHealth system inequalities**

- Variation in access to MHealth impacts MHealth system inequalities.
- Variation due to suitability of MHealth equipment impacts MHealth system inequalities.
- Variation in MHealth autonomy impacts MHealth system inequalities.

#### **MHealth utilisation inequalities**

- Variation in perceived benefits of MHealth impacts MHealth utilisation inequalities.
- Variation in perceived constraints of MHealth impacts MHealth utilisation inequalities.
- Variation in socio-demographic factors impact MHealth utilisation inequalities.

#### **MHealth communication inequalities**

- Variation in MHealth advocacy impacts MHealth interactive communication in/equalities.
- Variation in social networks in MHealth impacts MHealth communication inequalities.
- Variation in social support in MHealth impacts MHealth communication inequalities.

### **7.3.3 Intermediate factors directly impact inequalities in consumer MHealth**

The previous section shows how three antecedents directly impact the intermediate factors. This section shows how the intermediate factors directly impact inequalities in consumer MHealth. Thus, the three intermediate factors directly impact the inequality in consumer MHealth. Path diagram (chapter 5, figure 5.4) shows intermediate factors impact MHealth inequalities.

- MHealth system inequalities impact inequalities in MHealth
- MHealth utilisation Inequalities impact inequalities in MHealth
- MHealth communication inequalities impact inequalities in MHealth

### **7.3.4 Path Diagram and MHealth Equitable Service Model (MHESM)**

The path diagram (Figure 5.5) shows the hierarchies of the factors of inequalities in consumer MHealth. Figure 5.5 illustrates the hierarchies of the antecedents (first order), the intermediate factors (second order), and inequalities (third order) hierarchical models. Conversely Figure 5.6 presents the equity version of the path diagram. Figure 5.6 shows that equitable antecedents directly result to equitable intermediate factors which result to MHealth equitable service.

### **7.3.5 Development of MHealth Equitable Service Framework (MHESF)**

Chapter 6 develops the MHESF to address research question 3. The MHESF is an IS framework which addresses inequalities as the outcome of the stakeholders' activities across MHealth ecosystem. Chapter 6 outlines the MHESF integration matrix to mitigate MHealth inequalities.

- MHESF as multilevel MHealth ecosystem framework

MHESF is developed to target antecedents of inequalities in MHealth under MHealth system, utilisation, and communication. MHESF posits that a suitable integration of equity factors across the MHealth ecosystem essentially counteracts the inequalities in consumer MHealth for PAB population across the MHealth ecosystem. MHESF underscores the importance of reversing inequalities in MHealth by integrating equity factors at all activity levels encompassing technology, individual, social, organisational, and policy.

- MHESF for MHealth system, utilisation, and communication across MHealth ecosystem

MHESF is derived as multilevel MHealth ecosystem framework in contrast to behavioural model. Extant studies posit that inequalities in consumer MHealth are derivatives of low MHESF is distinguished from behaviour change models by recognising that inequalities are not just the result of low socioeconomic status or consumers' risk behaviour, but rather an outcome of MHealth ecosystem.

- MHESF is developed to mitigate antecedents of MHealth inequalities

MHESF is developed by using a matrix table of equity factors to counteract the nine antecedents of MHealth inequalities across the five factors of MHealth ecosystem

MHESF integrates equity factors to counteract inequalities at five MHealth ecosystem levels.

- Technology (hardware, software, communication networks)

- Individual (knowledge, attitude, skills, behaviour)
  - Interpersonal or social (family, friends, peers)
  - Organizational (structures, processes, work groups, professionalism)
  - Policy (regulations, policies, guidelines)
- MHESF counteracts antecedents of MHealth inequalities for equitable service.
    - Equity in MHealth system for access, suitability, and autonomy of equipment
    - Equity in MHealth utilisation to address perceived benefits, constraints, and demographics
    - Equity in MHealth communication to improve advocacy, social network, and social support.

## 7.4 Research Study Contributions

This section summarises the contributions of this research to MHealth research, to IS research field and to practice. The illustration in figure 7.1 distils the overlapping relationships of the contributions outlined in this section.

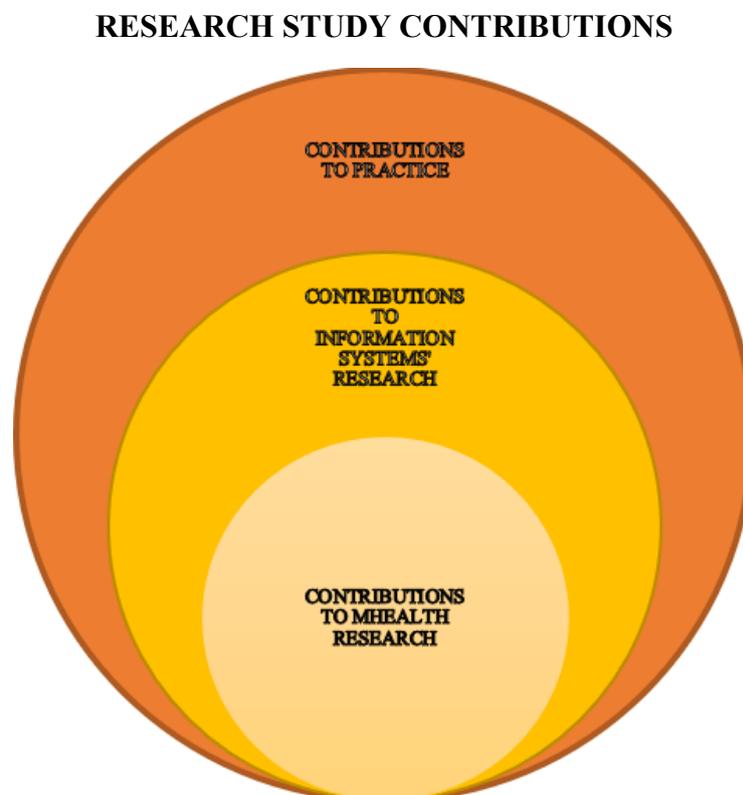


Figure 7.1 Research study contributions to theory and practice

## **CONTRIBUTION TO MHEALTH RESEARCH**

- Developed 12 factors for understanding MHealth inequalities.
- Provides taxonomy for examining MHealth inequalities
- Path diagram explains interrelationship of MHealth inequality factors
- Path diagram of MHESM

## **CONTRIBUTION TO INFORMATION SYSTEMS' RESEARCH**

- TAP and RPD methodology not previously documented in IS research.
- TAP and RPD gives voice to the voiceless underserved consumers
- Methodology embraces pre-implementation, implementation, and usage of MHealth
- Study bring clarity to measures of inequalities that undermines the underserved minorities
- Study shows socioeconomic factors is only one of nine antecedents of MHealth inequalities
- MHESM and MHESF contribute to IS theory

## **CONTRIBUTIONS TO PRACTICE**

- MHESM and path diagram are useful tools for understanding MHealth in/equalities
- MHESF provides broader framework to mitigate MHealth inequalities
- Study integrates social justice and equity as communal responsibility in MHealth delivery.
- Methodology provides 'work-through' for MHealth PAF implementation at multilevel

### **7.4.1 Contributions to Theory**

#### **Contributions to consumer MHealth research**

This study resolves the foundational theoretical problem of the lack of important concepts by developing the antecedents and intermediate factors which impact MHealth inequalities. The factors of MHealth inequalities provide a taxonomy for understanding MHealth inequalities. Especially, previous studies argue that inequalities in consumer MHealth derive from low socioeconomic status. However, this study developed nine antecedents and three intermediate factors which impact MHealth inequalities. This study marks a paradigm shift, especially in the prevailing notion that MHealth inequalities derive from socioeconomic factors. The study also developed and illustrates the relationship between the factors by leveraging a path diagram.

It is evident from the findings that low socioeconomic status is just one out of the nine antecedents that impact inequalities in consumer MHealth. The study also derived the

connection to show how social and demographic factors are linked to inequalities in MHealth utilisation. The study marks a paradigm shift which informs that MHealth inequalities are indeed the outcome of stakeholders' activities across the MHealth ecosystem.

- MHESM is the contrast of MHealth inequalities (chapter 5, figure 5.7)

Chapter 5 developed the relationship between the factors of MHealth inequalities. The interrelationships between the factors are illustrated by leveraging a path-diagram. The path diagram shows that inequalities in consumer MHealth is a third-order hierarchical model. The path diagram shows that the antecedents directly impact the intermediate factors, which subsequently impact inequalities in consumer MHealth. The discovery of the relationship among the factors provides the incentive for the MHESM which is the contrast of MHealth inequalities. The path diagram and MHESM provides explanatory powers for understanding equitable mitigation of inequalities in consumer MHealth.

- MHESF is a system change framework

Previous interpretations of inequalities in consumer MHealth have focused exclusively on behaviour change targeting individuals. (Free et al., 2010; Marcolino et al., 2018; Whitehead & Seaton, 2016). This research is distinguished from behavioural change models by focusing on system change. The current state of MHealth research is narrowly focused on life-style which attributes bad behaviour to individual responsibility alone (McLeroy et al., 1988). However, system change proponent maintain that individually focused behavioural change models have mainly promoted victim-blaming ideology by emphasising behaviour change as personal failures thereby ignoring the environmental factors that generate and sustain people's behaviour. Furthermore, system change advocates argue that little can be achieved by changing individual behaviour without changing social structures and processes within the system that collectively interact to shape the behaviour (Anderson & Aydin, 2005; Iivari et al., 1998; Kaplan & Maxwell, 2005).

MHESF is distinguished in its approach which recognises that inequalities derive from MHealth stakeholders' activities. MHESF is developed to counteracts inequalities by integrating equitable remedies to mitigate the multilevel factors targeting technology, individual, social, organisational, and policy. Details of MHESF development is covered in chapter 6.

## **Contributions to IS research**

Figure 7.1 distils the overlapping relationship of the contributions to information systems' research. This study illustrates how a theory building approach can provide rich insights into an under-investigated subject, by using multiple sources of qualitative data from TAP, RPD and in-depth interview to facilitate theory building. The research design involves the use of both think-aloud protocol (TAP), and the role-play demonstration (RPD), which made it possible for the participants to be deeply immersed into the socio-technical experience. The research methodology also provided a rare opportunity for the underserved minorities, the hard-to-reach, the voiceless population, to speak out. Furthermore, the study covers the breath of the four phases of technology experience at pre-implementation, at implementation, as well as the usage phase. This rigorous approach represents a scientific contribution which was not previously documented in any known qualitative IS research. Most importantly this study has paramount implications for social research, especially the IS discipline, which erroneously extrapolates the traditional measures of inequalities in a disproportionate way which undermines the underserved minorities, or the hard-to-reach, as they are pejoratively called.

### **7.4.2 Study contribution and the MHealth Debate**

#### **The contribution of this study brings clarity to the MHealth debate**

Research literature highlighted the lack of clarity on the fundamental nature of inequalities in MHealth. The lack of clarity and the divide in the MHealth debate has created several positions. The main proponents of the MHealth debate have their various position identified as pointed out in chapter 2. The extant literature shows there are four schools of thought with the following positions (chapter 2, Figure 2.5).

- SE disparities can undermine MHealth effectiveness (victim blaming ideology)
- MHealth can improve inequalities- the traditional measure -efficacy and cost-effectiveness
- MHealth can expand or widen inequalities (as an unintended consequence)
- MHealth can both improve and widen inequalities.

The role of the socioeconomic factors in the occurrence of inequalities in consumer MHealth can be explained from the path diagram of the relationships between the antecedents and inequalities in consumer MHealth. Taking an answer from the path diagram (Figure 5.5) shows there are nine antecedents, including socioeconomic factor as one of the antecedents of inequalities in MHealth.

Previous research says that SE disparities can undermine MHealth effectiveness. Without disputing that position, this study shows that there are nine antecedents that can undermine MHealth effectiveness. Previous study also says that MHealth can improve inequalities, however, this research shows that MHealth can improve inequalities if the antecedents are properly counteracted with corresponding remedies. Some studies maintain that MHealth can expand or widen inequalities, however, this research agrees with this position proves it with the antecedent factors. Finally, study holds that MHealth can both improve and widen inequalities, and this research confirms, that indeed, MHealth can either improve or widen inequalities if the antecedents are not properly countered.

### **7.4.3 Contributions to Practice**

- Path diagram provides explanation and understanding of inequalities in MHealth

The antecedents and the intermediate factors provide a clear path for the explanation, prediction, and for the understanding of inequalities in consumer MHealth. This study helps to understand the antecedents of MHealth inequalities. The research addresses the new ways by which digital technologies such as MHealth generate unfair differences and disadvantages that give rise to inequalities.

- Integrates social justice in technology innovation

Inequalities impact people in multiple ways by aggravating ill-health, limiting life expectancy, reducing human productivity, and increasing the social and economic cost of living. For the underserved population, inequalities represent a formidable challenge in several trajectories of life, arising from disproportionate wield of power, authority, or influence, as well as unequal application and adverse use of technology innovations. Consequently, inequalities in human interactions compel MHealth stakeholders to integrate social justice and equity as part of their collective and communal responsibility in the MHealth service. Inequalities represent a vicious cycle that impels us to combine equity, fairness, and justice in the ongoing digital health transformation, in which MHealth innovation is playing the dual role of both the instrument of service and the measure of success.

- Methodology is a work-through for the adoption of MHealth for physical fitness

The research methodology started from the formative stage of MHealth by asking questions about MHealth awareness, readiness, installation, and use of MHealth for physical exercise and fitness. Towards the end of the research the participants were so motivated that most of them

requested to retain their MHealth equipment. Due to interest and high demand, the researcher allowed all the participants to keep their fitness watches at the end of the data collection. The weighing scale was more expensive to give away, but many of the participants preferred to pay for the devices instead of handing them back to the researcher. To fill this gap, the researcher had to replenish the stock of devices at various stages by reordering new set of MHealth devices for the next stage of data collection. The eight weeks of MHealth usage period comfortably allowed the researcher to replenish without jeopardising the research process.

Similarly, the MHealth work-through is a viable project for individuals, families, and for health organisations and government. Especially, most of the participants who decided to continue using the MHealth devices try to communicate with the researcher to share their progress, make related enquiries and to resolve their technical challenges with the MHealth devices. In fact, both the researcher and the participants have treated this interaction for support with great interest that suggests the existence of a vacuum and an opportunity for health providers in the use of MHealth physical fitness and health promotion. The researcher thinks that this opportunity for MHealth promotion remains available at the time of this report. The vacuum in MHealth advocacy and communication provides an opportunity for government, the department of health, health insurance, as well as other health providers to try and engage in health promotional activities for groups of individuals and families. Health service providers in the United Kingdom and North America seem to be involved in this type of MHealth promotion. Therefore, the researcher thinks that the social promotion of MHealth is viable for the ROI, and the larger community of the European Union and the World Health Organisation (Boreham et al., 2004; Education & Welfare, 1979; Health & Children, 2009; Jefferis et al., 2014; Marques, Sarmiento, Martins, & Nunes, 2015; Oja, Bull, Fogelholm, & Martin, 2010).

## **7.5 Implications for Theory and Practice**

The current section focuses on the implications of the findings to MHealth research and practice. Figure 7.2 delineates the overlapping relationships of the implications outlined in this section.

## IMPLICATIONS FOR THEORY AND PRACTICE



Figure 7.2 Overlapping of the study implications for theory and practice

### IMPLICATIONS FOR FUTURE MHEALTH RESEARCH

- Confirmatory research is needed to ensure the verification of the result of this study

### IMPLICATIONS FOR FUTURE INFORMATION SYSTEMS RESEARCH

- Multidisciplinary and multilevel research requires to include other reference discipline and incorporate relevant organisational stakeholders

### IMPLICATIONS FOR INFORMATION SYSTEMS PRACTICE

- Provides taxonomy and framework of MHealth factors for guidance in planning and implementation of equitable MHealth innovation for PAB
- MHESM and MHESF provide multilevel guidance for MHealth implementation
- TAP and RPD protocols are walkthrough templates for MHealth implementation
- This study adopted the interpretivist paradigm; however, I believe that people apply a mix of all paradigms in real life, depending on their circumstances and what they need.

### **7.5.1 Implications for Future MHealth Equity Research**

- The missing Factors of MHealth inequalities

The research shows the absence of some factors which have not been derived. These missing factors call for further investigation (Figure 5.6).

- Confirmatory research is needed

This research is exploratory and provides insight and understanding of the problem of inequalities in consumer MHealth. The study requires confirmatory research with a mixed method that can integrate perspectives and establish the relationships between the constructs. Confirmatory research will ensure that these findings do not restrictively apply only to the data and context or restricted to the participants in this investigation.

- Requires multi-disciplinary research to include other stakeholders

Also, this research has implications for future information systems research. The multi-disciplinary nature of MHealth phenomenon calls for multilevel research collaboration to include major MHealth stakeholders in the national stage. The researcher calls for further research to include the various MHealth stakeholders, especially to combine with researchers from other disciplines and health organisations.

### **7.5.2 Implications for IS Practice**

- Taxonomy and framework of MHealth guidance

This study provides a taxonomy of the MHealth factors in IS research and practice. The study findings also provide a framework to guide MHealth stakeholders in their planning and implementation for equitable MHealth service. Also, the development of the MHESM presents the opportunity for practitioners to minimise the incidence of inequalities by localising potential sources of specific challenges in their SWOT analysis.

- Empowerment project for health providers, health insurers and government

This study methodology provides a template for a work-through at all stages of MHealth, starting from the formative stage of pre-implementation, implementation process and the post-implementation usage. This research presents opportunity for health care providers and health insurance firms who may want to use it as a template for health promotion programs.

### 7.5.3 Practical implications of the MHESF for PAB individuals

The implication of this research to practice for PAB individuals is the awareness it brings to MHealth stakeholders of the possibility of multilevel MHESF. The research shows how PAB individuals can leverage MHESF for MHealth communication and support to resolve limitations in access, suitability and autonomy of the MHealth equipment. MHESF shows that PAB individuals have opportunities to leverage information, communication and support to improve their utilisation, improve benefits, and reduce constraints. MHESF shows the possibility to apply MHealth for advocacy, social network and social support at interpersonal and organisational levels.

- At individual level

The MHealth technology resources are organised for information, communication and support to drive equity in MHealth by targeting individual characteristics such as knowledge, attitude, skills, and behaviour as opportunities to address equitable interest.

- At interpersonal levels

The MHealth equity of PAB individuals are improved by leveraging the dynamics of group interaction, within family members, among families, friends, peers, work groups as important sources of influence for equity in MHealth. Social groups are ready network which can be organised for MHealth advocacy, and support. Also, PAB can benefit from the involvement of professionals and health organizational stakeholders who have the competence to organise and address issues at higher levels. Professional and organisational stakeholders have the opportunity and competence to regulate the quality of equipment, recommend guidelines, and supervise national policy for MHealth users. It is relevant to quote one of the participants who said during the interview, “It was good, with my husband, sometimes we will discuss who did what and how many steps you have done. I guess the more family members are involved, the better. We can then all kind of compete with each other and see who's done more (Appendix M, GALWAY 5.2).

- At organisational level

Similarly, MHESF shows how MHealth technology resources can be organised for information, communication, and support through organisational structures, employee work groups, professional groups to stimulate MHealth equity. A participant said during the

interview (Appendix M, Galway 5.2), “we use something similar at work, in Boston Scientific, and it's very encouraging. And translating it into competition encourages people to do better and to do more”.

- At policy level

The MHealth technology resources are organised for information, communication, and support to drive equity in MHealth at policy level through national policy and regulatory instruments, which create the opportunities and enabling environment for MHealth equity.

#### **7.5.4 Practical implication for the MHealth antecedents**

- MHealth system inequalities, due to variation in access to MHealth

Access to health refers to the opportunity or ease with which consumers are able to use services for their needs. The variation in access to MHealth was found to be rooted in differences due to absence of internet connection, as well as the lack of awareness, knowledge, affordability and ownership of digital devices. Especially, the PAB individuals lacked awareness of mobile app and could not afford the MHealth resources, the digital weighing scale and activity sensor, they said.

For the MHealth system inequalities, due to the variation in access to MHealth, the PAB individuals can benefit from the awareness campaigns and device ownership organised at health organisational and policy levels. The lack of MHealth awareness can be resolved through government and organisational incentives to support MHealth services. Organised involvement of the government and health organisational stakeholders can incentivize MHealth awareness by providing supports.

- MHealth system inequalities, due to variation in suitability of equipment

Suitability of MHealth equipment is defined as the adequacy of MHealth equipment for the task. The variation in the suitability of MHealth equipment was found to be rooted in differences due to the quality of digital devices. PAB individuals are prone to seek inferior hardware and software, proprietary devices, legacy and intra-operable systems, and use of dysfunctional network to reduce cost. Suitability of equipment is caused by poor quality products which affect functionality, interoperability and compatibility of the digital devices and mobile software application. Especially inferior digital devices capture the interest of low

income buyers due to affordability. Unfortunately, inferior health devices are unsuitable and prone to faults and false information which are inimical to health.

For suitability, PAB individuals have the opportunity to leverage the professional competence and support of governmental and health organisational stakeholders to obtain quality MHealth. The government and health organisational stakeholders have the capacity to address issues of compatibility and interoperability, especially if they are mutually engaged in a working relationship with the PAB consumers. Compatibility and interoperability of the MHealth software and devices are choices that require professional competence. This role can be undertaken by health agencies at the organisation and policy levels.

- MHealth system inequalities, due to the variation in autonomy of MHealth equipment

Autonomy of MHealth equipment is the level of user control of the MHealth equipment. The variation in the suitability of MHealth equipment was found to be rooted in differences in the consumer ability to control the digital resources due to restrictions from internet connection, restriction in mobile software service, centralised data management, restricted user time, limited user functionality, and other regulated user functions and agreements.

Again, free health software is the norm for PAB who are price sensitive for software service subscriptions, and go for free software apps with hidden costs. Other limitations of PAB participants include the restrictions in the control and management of personal data. Quite often, free mobile apps engage in secret data-minning of the users health data based on software agreements which were not explicit to the consumer at the time of download. PAB consumers may not know explicitly who controls their data, and may be unaware of privacy and security concerns. PAB are unaware of what happens to the data when the customer is no more interested in using the app. Data control limitations are questionable, especially about data residence, whether on the personal phone or a remote database. There are user limitations imposed by the device functionalities by manual and automated controls.

For autonomy, PAB individuals have the opportunity to leverage the involvement of health organisational stakeholders for professional competence. For example, PAB individuals have the opportunity to rely on health organisational stakeholders for regulation and oversight of MHealth software and devices. Many of these teething troubles can better be advised or handled by professional stakeholders. For example, the system designers have to take the characteristics of the PAB into consideration at the design phase. Therefore it is advisable to

involve PAB individuals at the design stage and not to focus on only mainstream characteristics by neglecting the unique requirements of the PAB.

- MHealth utilisation inequalities, due to the variation in perceived benefits of MHealth

User perceived benefits or usefulness of MHealth is the degree to which a person believes that using a particular system would enhance their job performance. The variation in the perceived benefits of MHealth by PAB are caused by the lack of self-care knowledge and limited health experience. To improve perceived benefits, PAB individuals have the opportunity to leverage social and organisational support organised by stakeholders. PAB health knowledge and awareness can be improved by interaction and campaign organised at social and organisational levels.

- MHealth utilisation inequalities, due to variation in perceived constraints of MHealth

User perceived constraints of MHealth are perceived barriers or inhibitions associated with demotivation in the use of MHealth innovation. The variation in the perceived constraints by PAB include lack of time to use the MHealth due to family and work, and misdirected interest, e.g. watching television. Other factors include lack of technical and health skills, the lack of motivation and interest, lack of knowledge and experience in self-care, and poor feedback information. For the user perceived constraints, PAB individuals have the opportunity to leverage social interaction, organisational support and training to improve digital literacy and improve app and MHealth device skills.

- MHealth utilisation inequalities, due to variation in the demographic factors

The disadvantage due to demographic factors comprise of the characteristics of the PAB participants captured during survey in this research . The social and demographic disadvantages include factors related to age, education, employment, income, location, race and culture. To address the demographic challenges, PAB individuals have the opportunity to leverage social network supports from family members, peer groups, and organisational support to overcome demographic challenges relating to education, literacy and skills for MHealth

- MHealth communication inequalities, due to variation in MHealth advocacy

MHealth advocacy is the strategic use of MHealth information and resources to systematically reduce the occurrence or severity of public health problems, by targeting specific individuals and those with whom they live and relate. PAB individuals have the opportunity to leverage

the advocacy services from organisational and policy levels to improve communication about MHealth. This involves PAB engagement in health promotional activities organised by health organisational stakeholders. PAB have opportunity to engage with MHealth promotional activities. MHealth promotion and disease prevention create opportunities for skills in selfcare, bringing attention to national guidelines on physical activities (PA) with MHealth, creating awareness of sedentary risk factors, integrating families and social groups with MHealth activities through advocacy.

- MHealth communication inequalities, due to variation in MHealth social network

MHealth social network is defined as the web of social relationships that surround specific individuals and those with whom they live, and the larger community to which the individuals are tied. PAB individuals have the opportunity to leverage social networks which can be organised through the involvement of organizational stakeholders. Social network can integrate PAB family members, friends and peers, parents and children, groups of students, and staff members at work place to engage socially with MHealth services.

- MHealth communication inequalities, due to variation in social support in MHealth

MHealth social support is defined as the social influence, companionship, and support arising from the web of social relationships that surround specific individuals and those with whom they live, and the larger community to which the individuals are tied. PAB individuals have the opportunity to leverage social support from family members, from friends and peer groups, social groups, from office staff member support to drive the use of MHealth through the communication and organizational involvement.

## 7.6 Potential Limitations and Future Research Opportunities

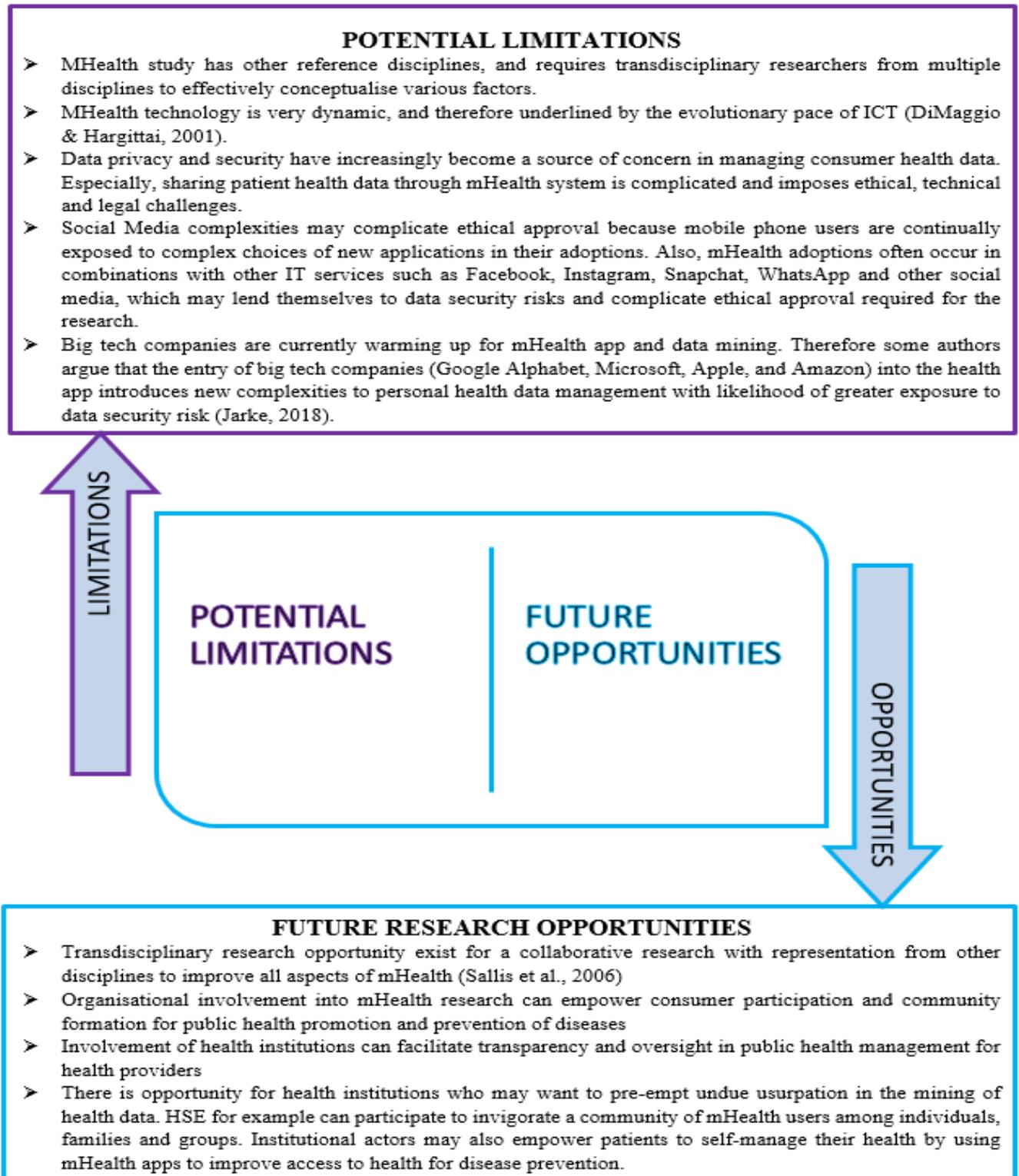


Figure 7.3 Illustration of potential limitations and future research opportunities

### **7.6.1 Potential Limitations**

- Transdisciplinary research require representation from other disciplines

Multilevel research requires researchers from multiple disciplines to effectively conceptualise the different subject matter involved in a transdisciplinary research (Sallis et al., 2006)

- Some measures of MHealth are dynamic and underlined by the evolutionary pace of ICT.

Extant literature argues that these measures of inequalities are dynamic and underlined by the evolutionary pace of the information and network society (DiMaggio & Hargittai, 2001).

- Data privacy and security concerns

Consumer health data are increasingly exposed to security concerns. Especially, sharing patient health data through MHealth system is complicated and imposes ethical, technical, and legal challenges.

- Social Media complexities may complicate ethical approval

Mobile phone users are continually exposed to complex choices of new applications in their adoptions. Also, MHealth adoptions often occur in combinations with other IT services such as Facebook, Instagram, Snapchat, WhatsApp, and other social media, which may lend themselves to data security risks which may also complicate ethical approval required for the research.

- Big tech companies for MHealth app and data mining

Some authors argue that the entry of big tech companies (Google Alphabet, Microsoft, Apple, and Amazon) into the health app introduces new complexities to personal health data management with likelihood of greater exposure to data security risk (Jarke, 2018).

- Paradigmatic thinking is complex

Although this research adopted the interpretivist paradigm, there is no such thinking in reality as people adopt different thinking in various situations

### **7.6.2 Future Research Opportunities**

- Transdisciplinary research with a good representation from other disciplines

MHealth research is a sociotechnical discipline, which creates a collaborative opportunity for researcher from other IS reference disciplines. In order to enrich future investigation in MHealth inequalities, there is need for transdisciplinary researchers in order to improve representation from other disciplines, and to effectively coordinate the combined body of knowledge involved in transdisciplinary research (Sallis et al., 2006)

- Organisational involvement into MHealth research

Corporate organisational involvement into MHealth research has potentials to enable MHealth consumer participation and community formation. It can also empower communication and interaction aimed to unearth the potential application of MHealth especially for public health promotion and prevention of diseases

- Opportunity for transparency and oversight

There is an opportunity to institutionalise MHealth administration, for example, through the interest of the national health service provider and national policy framework. Organisational involvement will pre-empt undue usurpation in the mining of health data. Organisational participation can also invigorate the use of apps among individuals and perhaps for families. Institutional participation may also empower patients to self-manage their health by using MHealth apps to improve access to health for disease prevention.

## **7.7 Summary and Conclusion**

Chapter 7 provides a concise summary of the research findings. The chapter started by restating the research objective and research questions, with a brief summary of the methodology applied. The chapter discusses the research findings addressing research question 1. It provides a summary of the nine antecedents and three intermediate factors of MHealth inequalities developed in chapter 4. It further discusses the findings in chapter 5 addressing research question 3, and the intermediate factors and the interconnection between the antecedents and the MHealth inequalities. Furthermore, the chapter discusses the path diagrams and the resulting MHESM which is the antithesis of inequalities in MHealth. The discussion addresses research question 3 in the development of MHESF as multilevel ecosystem framework for mitigating MHealth inequalities.

Chapter 7 further focuses on the study contributions to MHealth research, IS research and contributions to practice. This study contributions include the developing the nine antecedents,

and the three intermediate constructs for understanding MHealth inequalities. The methodology was novel in the application of TAP, RPD and grounded theory analysis which developed the factors of MHealth inequalities. The study outcome clearly reveals that socioeconomic factor is one part of the nine antecedents that impact MHealth inequalities. Also, the development of MHESM and the MHESF are important contributions to MHealth and the IS research. Consequently, the IS stakeholders and the PAB can leverage the MHESF at multilevel of technology, individual, social, organisational and policy to mitigate inequalities in consumer MHealth innovation.

However, this research is transdisciplinary and requires complementary representation from relevant IS reference disciplines. It also requires the involvement of other MHealth stakeholders for rich insight. Furthermore, qualitative studies of this type are exploratory, and focuses on relevance. Notwithstanding, this study derived the antecedents of MHealth inequalities, the MHESF for mitigating, and provides insights which paves way for further investigation.

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## APPENDIX A: Selected MHealth Literature (2012 – 2020)

Author(s), Year & Discipline	Title	Study focus/theme	MHealth type and service	MHealth users involved / target population/Location	Disease/health process targeted	Phase of healthcare delivery process	Research Method/theory	in/equalities/ antecedent factors	Research contributions
Armaou, Araviaki, & Musikanski, 2020	eHealth and Health interventions for ethnic minority and historically underserved populations in developed countries:	Evidence of effectiveness of eHealth/MHealth interventions among underserved in developed counties and recommendations	interventions delivered by computer programmes, cell phones or other electronic devices.	historically underserved/disadvantaged populations in developed countries	physiological wellbeing	physiological wellbeing, health knowledge and self-management	theory testing-umbrella review of systematic reviews	acceptability/effectiveness of eHealth/MHealth	disadvantaged populations can undermine effectiveness of eHealth; it limits acceptability by community members
Bommakanti, Smith, Liu, Do, Cuevas-Mota, Collins, & Garfein, 2020; Public health	Requiring smartphone ownership for MHealth interventions: who could be left out?	implementing MHealth interventions can create health disparities due to inequalities in smartphone ownership	smartphones/ video capture	TB patients in disadvantaged populations; USA	monitoring tuberculosis (TB) treatment adherence	Behaviour Adherence Support during follow-up treatment	theory building-MHealth intervention	smartphone ownership or access to mobile technology	Older, male participants, low income, likely unable to own a smartphone and not getting MHealth service.
Crawford & Serhal, 2020; medicine/technology	The innovation curve cannot reinforce the social gradient of health.	low SE status [poverty, lack of access, low digital health literacy, and poor engagement with digital health] can undermine MHealth outcomes	Digital health innovations/MHealth provide virtual access to vital health services/allow social distancing/minimized exposure to infection during COVID-19 pandemic.	low SE population, poverty, lack of access & poor engagement, literacy as barriers to MHealth outcomes, Toronto, ON, Canada.	poor health outcomes in coronavirus disease (COVID-19) pandemic	MHealth Disease Prevention & health promotion	Model extension-MHealth intervention/elaboration of digital health equity factors outlined by Dover and Belon [7] in 2019	Multilevel Digital Health Equity Framework to be incorporated into health provider training at individual, institutional, and social levels.	MHealth provide access to essential health care/health provider training should be incorporated at all levels to avoid inequalities exemplified in COVID-19 pandemic.

Sawert, & Tuppatt, 2020; behavioral sciences	Social inequality in the digital transformation Risks and potentials of mobile health technologies for social inequalities in health	Social inequality in the digital transformation: Risks and potentials of mobile health technologies for social inequalities in health	MHealth - smartphones	groups with low versus high socio-economic status; Germany			theory building- secondary data analysis used to develop a theoretical model for inequality MHealth usage, health behaviour and health satisfaction.	MHealth usage: Among smartphone users, higher educated respondents are more likely to use health/fitness apps.	
Mayberry, Lyles, Oldenburg, Osborn, Parks, & Peek, 2019; medicine tech	MHealth interventions for disadvantaged and vulnerable people with type 2 diabetes.	Acceptance and benefits of MHealth interventions by vulnerable persons with diabetes (PWD)	Mobile device and Internet	low SE status, race/ethnicity, minority, rural setting, low-/middle-income country, disadvantaged/ vulnerable persons with diabetes; LMIC	persons with diabetes (PWD)	MHealth Behaviour Adherence Support	theory building; Lit review; synthesis of lit information	provide recommendations for increasing access, and improving the design and usability of such interventions	evidence suggesting that digital interventions can improve diabetes control, healthcare utilization, and healthcare costs
Noteboom, Xiong, Qureshi, Iyer, & Noteboom, 2019; Health tech	Overcoming Health Inequities in Native American Tribal Populations through MHealth	what /health disparities in rural tribal communities can be overcome through MHealth?	MHealth	Native American Tribal Populations living on American Indian Reservations; USA	disparities that affect the well-being of the population.	Access to hospital for treatment	variables and models; Mixed method approach	living conditions, access to clinics and hospitals, and mobile health access affect the well-being of a population.	Contributions are offered on understanding how to overcome health disparities in rural tribal communities using MHealth.
Qureshi, Xiong, & Deitenbeck, 2019; Health tech	Using Digital Tools to Improve Policy Making and Citizens' Decisions in Healthcare.	there's relationship between MHealth, social inequalities in life expectancy and in education on Human Development and Health and Wellbeing.	mobile health				theory building; Quantitative; using multiple regression analysis	Mobile Phone Subscriptions Internet Usage Health Index (MPSIUHI) has a positive effect on the Human Development Index.	
Anderson-Lewis, Darville, Mercado, Howell, & Di Maggio, 2018; Health tech	MHealth technology use and implications in historically underserved and minority populations in the United States:	examines the ways in which MHealth strategies are being employed in public health interventions to these priority population groups,	mobile phone capabilities include text messaging, mobile apps, internet access, emails, video streaming, social media, instant messaging, and more.	Minority, underserved populations; USA	Risk population: diabetes, sexual, reproductive, maternal, child, influenza, HIV and AIDS	MHealth Disease Prevention & health promotion	theory building; Systematic Reviews and Meta-Analyses	access health information due to increased access to smartphones.	MHealth is able to increase prevention and health education in the health of traditionally underserved communities and minority populations

Jarke, 2018; Health tech	MHealth– Friend or Foe in Reducing Inequality?	disadvantaged groups who do/do not benefit from MHealth interventions? 2) What barriers to equal gains? 3) What barriers specific to groups/systematic bias towards disadvantaged populations? Under which social, economic, and cultural conditions do individuals in France more likely to be actively interested in self-tracking diet and fitness apps for better health behaviours.	MHealth interventions—such as apps or text-based support	low level education and low SES can be barriers to benefit from MHealth; Brussels, Belgium	General MHealth use; reproductive, child, and sexual health; Diabetes Type-2; Overweight	MHealth Disease Prevention & health promotion	theory building; Systematic Lit Review of MHealth intervention	Patients with limited language proficiency, low level of education and lower socioeconomic status can be barriers to use of MHealth for reproductive, child, and sexual health	low education and low SES can be barriers to MHealth benefits
Régnier & Chauvel, 2018; Health tech	Digital inequalities in the use of self-tracking diet and fitness apps: interview study on the influence of social, economic, and cultural factors	MHealth improves/save lives in low- and middle-income countries but very few studies examine its effects on health equity, gender, and power dynamics.	diet and fitness self-tracking apps (Weight Watchers, MyFitnessPal, and sport apps)	Existing users of 3 diet and fitness self-tracking apps; France	diet and physical activity	MHealth Behaviour Adherence Support	Mixed method	social, economic, and cultural conditions individuals	Individuals from lower milieus were more reluctant to use digital devices relating to diet and physical activity or to participate in self-quantification.
Sinha & Schryer-Roy, 2018; Health tech	Digital health, gender and health equity: invisible imperatives.	The usage of mobile phones for childbirth/ SE disparities, and uptake of mobile phones for postnatal care	eHealth, MHealth or 'digital health	community members, community health workers, local communities, and decision-makers; low/middle-income countries	crosscutting HIV treatment, pregnancy service, refugee services	crosscutting	theory building/ health equity and gender analysis; Qualitative evaluative activities across the entire cohort.	gender, power relations, class, race, education, ethnicity, age, geographic location, (dis)ability and sexuality	Digital health influence health equity; gender/power analyses are essential; digital health can be used to strengthen upward and downward accountability.
Bishwajit, Hoque, & Yaya, 2017; Health tech	Disparities in the use of mobile phone for seeking childbirth services among women in the urban areas: Bangladesh Urban Health Survey.		mobile phone for seeking childbirth	married women from marginalized and underserved population; South Asia, Bangladesh, Urban	childbirth services	MHealth Disease Prevention & health promotion	theory building- variable of mobile phone utilization; Quantitative	Neighbourhood, educational and economic factors were significantly associated with the mobile phone utilization status among urban women	eHealth/MHealth minimise the impact of socioeconomic barriers and promote the utilization of maternal healthcare services

Heitkemper, Mamykina, Travers, & Smaldone, 2017; Health tech	Do health information technology self-management interventions improve glycaemic control in medically underserved adults with diabetes?	The effect of health information technology for diabetes self-management education/ interventions on glycaemic control in medically underserved patients	HIT, a combination of text messages to cellular phones and automated calls to landline phones	racial/ethnic minorities and medically underserved patients with diabetes; USA	MHealth intervention effect on glycaemic control of diabetes self-management education, Behaviour Adherence Support	MHealth Behaviour Adherence Support	psychosocial and physiologic outcomes were measured in all studies; Lit review and meta-analysis	self-efficacy, satisfaction with medication information, patient activation or ability to manage one's health, and overall self-care behaviours	medically underserved patients with diabetes achieve glycaemic benefit following health information tech
Khatun, Heywood, Hanifi, Rahman, Ray, Liaw, & Bhuiya, 2017; Health tech	Gender differentials in readiness and use of MHealth services in a rural area of Bangladesh.	presents gender differentials in the ownership of mobile phones and knowledge of available MHealth services in a rural area of Bangladesh	MHealth	Traditional gender gap between men and women lagging behind men in the use of modern technologies, especially in developing countries; Bangladesh, Rural	gender gap in the ownership, access, and use of mobile phones; women lagging behind men in the use of modern technologies,	MHealth Disease Prevention & health promotion	Theory building; Quantitative	Variables such as: mobile phone awareness; Knowledge of 'Health; Knowledge of government MHealth services; Intention to use MHealth services in future	Compared to men, women are less likely to own a mobile phone and less aware of available MHealth services
Latulippe, Hamel, & Giroux, 2017; Health tech	Social health inequalities and eHealth: a literature review with qualitative synthesis of theoretical and empirical studies.	ensure eHealth reduce not increase SHIs of people at risk; develop eHealth to reduce SHI, and for vulnerable.	eHealth (found to include MHealth)	Ethnicity and low income are the most commonly used characteristics to identify people at risk of SHI	SE factors seen as disease: health inequality due to : Ethnicity, low income, education age, literacy, gender rurality, incapacity, distress, homelessness, sexuality		Theory building, Lit review	reducing SHI via universal access to eHealth, mark users' literacy level, culture	eHealth can both reduce or increase social inequalities
Nelson, Mulvaney, Gebretsadik, Ho, Johnson, & Osborn, 2016; Health tech	Disparities in the use of a MHealth medication adherence promotion intervention for low-income adults with type 2 diabetes.	What factors impede engagement in MHealth medication adherence promotion intervention for low-income adults with type 2 diabetes (T2DM).	MHealth intervention called messaging for Diabetes that leveraged a mobile communications platform	diabetic patients; USA	diabetes	MHealth Behaviour Adherence Support	Theory building; MHealth intervention	Racial/ethnic minorities, older adults, and persons with lower health literacy or more depressive symptoms appeared to be the least engaged in a MHealth intervention.	To facilitate equitable intervention impact, future research should identify and address factors interfering with MHealth engagement.

Yang & Varshney, 2016; Health tech	A taxonomy for mobile health implementation and evaluation.	develop a taxonomy of research papers on the topic of mobile health project implementation and evaluation.						Theory building; Lit review		
Barlott, Adams, Diaz, & Molina, 2015; Health tech	Short message service (SMS) reduce exclusions of caregivers from disabled in resource-limited Colombian community	evaluating experience of caregivers using SMS as for information access and interaction with disabled people with disabilities	mobile phone SMS	used to reduce exclusion of people with disabilities (PWD) from caregivers; Colombia	interaction with caregivers of people with disabilities (PWD).	MHealth Behaviour Adherence Support		theory building - recommendations to improve intervention outcome for people with disability; Mixed method	themes and categories identified opportunities for community intervention	SMS help share information and reduce isolation and provide social support network
Kumar & Arya, 2015; Health tech	MHealth approach for health literacy/patient-physician communication, HIV testing	Exemplar for improving patient-physician communication and increasing HIV testing through a text message intervention.		improving patient-physician communication; USA	HIV Testing	MHealth Behaviour Adherence Support		theory building; Narrative Literature	low health literacy	
Jennings, & Gagliardi, 2013; Public Health	Influence of MHealth interventions on gender relations in developing countries:	Evidence of changes in men and women's interactions as a result of MHealth interventions.	mobile phone(s); SMS; text(s); audio message(s); smart phone(s); Health; eHealth	gender relations between men and women; developing countries	health; maternal; birth(s); Sexual Health and HIV/AIDS; Cancer:	behaviour adherence		theory building-presented findings; Lit review of interventions	Evaluation of a mobile health intervention/ presented findings on resultant dynamics between women and men.	MHealth can beneficially influence gender relations, while at the same time strain and reinforce existing power imbalances. people are caught in a vicious cycle of digital access inability to make beneficial use reinforces existing disadvantage
Baum, Newman, & Biedrzycki, 2012; Public Health	Vicious cycles: digital technologies and determinants of health in Australia.	Differential impact of digital technologies on people from low socio-economic backgrounds	digital (health) technologies on	people from low SE population; Australia	health and well-being of people from low socio-economic backgrounds.	ways in which social, cultural and economic capitals interact to reinforce inequities		theory testing; Qualitative	Bourdieu's theories of social inequities/how sociocultural and economic capitals interact to reinforce inequities	

## APPENDIX B: Interview Guide

### A. Introduction

1. Thank you for your participation in our study! We greatly appreciate your acceptance to participate.
2. **Research Title:** M-Health Inequalities and the Equitable Remedy in Digital Health Innovation- Investigating the antecedents of health inequities associated with the application of digital health technologies (m-health for physical exercise) by racial/ ethnic African minority domicile in the ROI
3. **Purpose of the Study:** To explore the socioecological antecedents of health inequities caused by the application of digital health technologies (m-health)
4. **Relevance of the study:** An attempt to mitigate the injustice of health inequities imposed by the application of digital health technologies. M-Health equitable remedy is a social innovation for digital health equality, diversity, and inclusion.
5. **Current challenges:** Health inequities and their impact are damaging, costly, invisible, and presently not measured. While the proliferation of digital technologies keeps rising the consequent fallout of ‘digital technology injustice’ of health inequity increases progressively, however, unnoticed.
6. The **Information Sheet and the Consent Form** are presented to the prospective participant for careful reading (allow time to revert to researcher).
7. If the participant is willing and ready to participate in the study, he/she signs the Consent Form. Both the participant and the researcher retain a copy each.
8. Again, restate your commitment to anonymity and confidentiality of the participant and provide verbal assurances that the personal identity of the interviewee is not required.
9. Also, provide the participant the opportunity to state any concerns or to request additional information for clarification.
10. What is next as the continuum of this research: This is a basic as opposed to applied research, both of which rests on either end of a continuum. This basic research is motivated by the interest in the topic with a goal to learn more about the phenomenon. However, applied research at the positive end of the continuum, is conducted purposefully, sometimes beyond or in addition to a researcher’s interest in a topic. Applied research is often client focused, meaning that the researcher is investigating more factors, or a particular question posed by other interested parties related to public interest or on client-determined questions.

## APPENDIX C: Information Sheet

Thank you for considering participating in this research project. The purpose of this document is to explain to you what the study is about and what your participation would involve, to enable you to make an informed decision.

**The study title:** M-Health Inequalities and the Equitable Remedy in Digital Health Innovation

**The Purpose of the study:** The purpose of this study is to explore the antecedents of the health inequalities associated with m-health usage behavior of the ethnic African population in the ROI

**Participation in the study involves some ‘role-playing’ and interview-** Should you choose to participate; you will be asked to take part in a one-to-one role-playing and interview with a member of the research team. The interview will be audio-recorded and takes about 30 minutes to complete.

**Participation in the study is voluntary:** Participation in this study is voluntary, and there is no obligation to participate. You can refuse to answer specific questions or decide to withdraw from the interview at any time. At the end of the interview, the participants can decide to withdraw their data up to 2-weeks after interview.

**Transcripts of the interviews are anonymous:** The transcripts of the interviews are anonymous. This study ensures the anonymity of transcript data, such that no information about participant’s identity will appear in any work arising from this research. Instead, pseudonym is used to refer to participants and all the individuals or group of people involved.

Participants’ anonymity is achieved by replacing direct identifiers such as place, organization, position, title, number of years, dates and any similar information. Names are replaced with numbers, and other information such as age, are aggregated to avoid direct traceability.

**The participant is required to sign the consent form:** If you decide to participate in this study, there is a consent form attached which you can sign to indicate that you have read the information sheet that you understand it and you are willing to participate in the study. The researcher should retain one copy of the consent form, while the participant should also retain a copy of the consent form. The signed and dated consent forms is stored by the researcher, in a secure (locked) location from time of receipt until scanned and stored at UCC supported safe storage for up to 10 years, and the hard copies are shredded at the end of the research study by the researcher.

**Data protection and anonymity of transcript is maintained in according with EU GDPR (Recital 26)** The principles of data protection do not apply to anonymous data, namely information which does not relate to an identified or identifiable natural person or to personal data rendered anonymous where

the data subject is no longer identifiable. GDPR does not therefore concern the processing of such anonymous information, including for statistical or research purposes.

### **Data Storage and Confidentiality**

Once the interview is completed, the researcher immediately transfers the recording to his/her encrypted laptop and wipes out the recording from the device. The researcher transcribes the interview and removes all identifying information. Subsequently, the researcher deletes the audio recording and retains the anonymized transcript. The researcher shreds the hard copies of the Consent Forms and the transcripts at the end of this study. The electronic transcript is stored at UCC supported safe storage for ten years.

**Information from the study may be used in research publication:** The information you provide may contribute to research publications and/or conference presentations, including a thesis and a research report.

**What you can do in the event of a negative outcome:** We do not anticipate any negative outcomes from your participating in this study. However, at the end of the procedure, I will discuss with you how you found the experience and how you feel. Should you experience distress arising from the interview, the contact details for support services provided below may be of assistance?

**The ethics committee, at UCC, approves this study:** This study has obtained ethical approval from the UCC Social Research Ethics Committee. Email: [srec@ucc.ie](mailto:srec@ucc.ie)

### **These are useful contact information:**

- Rowland Njoku (Researcher) Phone: + 353 851091919 E-mail: [rownjoku@gmail.com](mailto:rownjoku@gmail.com)
- Professor Frederic Adam (Supervisor), Phone: +353 214903343 E-mail: [FAdam@ucc.ie](mailto:FAdam@ucc.ie)
- Dr. Simon Woodworth (Supervisor), Phone: +353 214903830 Email: [s.woodworth@ucc.ie](mailto:s.woodworth@ucc.ie)
- The HOD, BIS, UCC. Phone: +353 (0)21 4903829 Email: [bis@ucc.ie](mailto:bis@ucc.ie)

***If you agree to take part in this study, please sign the Consent Form***

## APPENDIX D: Consent Form

**Study Title:** Mobile-Health Equitable Remedy - *Investigating the antecedents of health inequalities associated with m-health usage behaviour of the ethnic minority population.*

- I.....agree to participate in the research study, by Rowland Njoku, titled: “mobile-health equitable remedy - investigating the antecedents of health inequality associated with m-health usage behaviour of an ethnic minority population”.
- The researcher has given me a written explanation of the purpose and nature of the study.
- I am participating voluntarily in this study.
- I have given permission for my interview with Rowland Njoku to be audio-recorded.
- I understand that I can withdraw from the study, without repercussions, at any time, before it starts or while I am participating.
- I understand that anonymity of information is ensured in the interview transcript and in the write-up.
- I understand that I can withdraw permission to use the data within two weeks of the interview, in which case the material will be deleted.
- I understand that hard copies of the Consent Forms and the transcripts of interviews will be shredded by the researcher at the end of this study, while the electronic transcript will be stored at UCC supported safe storage for 10 years’ period.
- I understand that unanimous and disguised extracts from my interviews may be quoted in the thesis and any subsequent publications if I give permission below.
  
- **(Please tick one box in the option :)**
- I agree to quotation/publication of extracts from my interview
- I do not agree to quotation/publication of extracts from my interview

Signed: .....

Date: .....

PRINT NAME: .....

## APPENDIX E: Socio-Demographic Survey

### Data Gathering 1

#### PRE-IMPLEMENTATION OF MHEALTH

##### Population of African Background (PAB)

- The study was conducted in three Provinces of the ROI. This aspect of the study involved a total of 24 surveys questionnaires with individuals of PAB from 12 households, between July 2019 and March 2020.

#### Face to Face, socio-demographic survey of participant's characteristics

*Also, as part of sampling tool (Coleman, Williams, & Wilson, 1996; Robinson, 2014)*

The target participants characteristics include questions on the

- Individual ascriptive factors
- Socio-economic variables (SES)
- Behavioural risk factors
- Environment and contextual factors
- Technology resources such as ownership of mobile phones and internet availability

**Time: About 5 - 6 minutes**

#### **Information**

*This study was approved by the Social Research Ethics Committee (SREC) of the University College Cork. In compliance with the UCC SREC requirement, a written information document ensuring confidentiality and anonymity was given to participant. Also, a written informed consent was obtained from the participant, and a debriefing document is administered at the end of the in-depth interview at post-usage phase.*

- *Please note that the information from this research study is anonymous and confidential, and we assure you that the discussion is not personally attributed to you, or anyone.*
- *You are allowed to request additional information for clarification if you wish to do so, or to state any concerns you may have with the process at any time.*

#### SURVEY QUESTIONNAIRE

## 1 SOCIO-DEMOGRAPHICS CHARACTERISTICS

Name of Participant	
Research Activity Location	
Date	

### *Fixed (or ascriptive) Factors*

1	Age		18-19	20-29	30-39	40-49	50-59	60-64
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2	Race and ethnicity: African (By 5 UN sub regions)	East Africa	Central Africa	Southern Africa	West Africa	North Africa	other
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3	Gender	Male	Female
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4	Household size	1	2	3	4	5	5	5+
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5	Household Members Employed	1	2	3	4	5	6	6+
6	Subsidiary family dependants	1	2	3	4	5	6	6+

### *Socio-economic variables (SES) - Proxies for low SES*

7	Occupation (Kim & Park, 2012)	Clerical	Professional	Homemaker	Student	Self-employed	Manufacturing	Government official	other
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8	Annual Personal Income distribution in thousand Euros (CSO, 2019)	00-10	10-20	20-30	30-40	40-50	50-60	60-70	70+
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9	Annual Household Income distribution in thousand Euros (CSO, 2019)	00-10	10-20	20-30	30-40	40-50	50-60	60-70	70+
10	Average Annual Household Income distribution in thousand Euros (CSO, 2019)	00-10	10-20	20-30	30-40	40-50	50-60	60-70	70+

11	Education level	<Primary	Secondary	College	Graduate	Post-Graduate
----	-----------------	----------	-----------	---------	----------	---------------

12	Politically Active	No	Yes
13	Health Insurance	No	Yes
14	Life insurance	No	Yes
15	Home Insurance	No	Yes
16	Pension Scheme	No	Yes

### **Behavioural risk factors**

17	Smoker	No	Yes			
18	Drug use	No	Yes			
19	Current PA Level (Health & Children, 2009)	1 No activity	2 Low activity – short walks, few stretches, home exercises	3 Medium activity: 30' x 5 days or 150 minutes weekly	4 High activity 30'x 6 days weekly	5 Very high activity: intensive PA training x one-hour daily

### **Environmental Factors**

20	Residential Neighbourhood opportunity for PA	No	Yes
21	Workplaces opportunities for PA	No	Yes

 **Technology Resources**

22	Landline Broadband	No	Yes
23	Mobile Phone Internet	No	Yes
24	Pay as You Go Internet	No	Yes
25	Desktop or Laptop Computer at home	No	Yes

26	Mobile Phone Type	Android Phone	Apple Phone	Other
27	Do you have Mobile Health Devices or App	No	Yes	
	Survey Time Duration (hr:min)			

**Thank you for your participation**

## **APPENDIX F: Data Collection using TAP and RPD.**

### **Introduction to TAP and RPD.**

The study on MHealth inequalities was conducted across three Provinces of the ROI. In total 24 individuals of ethnic minorities of African background (PAB) participated in both ‘think-aloud protocols’ (TAP) and ‘role play demonstration’ (RPD). The TAP and RPD were conducted with each of the individuals of PAB from 12 households, between July 2019 and March 2020.

The MHealth inequality is a new study area which requires original study insight. Extant literature shows that unless research participants are extremely insightful, they might not know or remember all the rationale for their behaviour or reasons why they do things (Strauss & Corbin, 1998). Extra efforts were directed towards direct observational evidence in order to capture the overall context and situational circumstances surrounding MHealth inequalities. The researcher entered the field of study without a pre-existing notion of the phenomenon and with “original insight”. The originality of this study necessitated the use of TAP and RPD, devised as a template for apprehending the true nature of the phenomenon, since there was no preconception or even existence of hypothesis of the area of study before entering the field of study (Goulding, 1999; Moghaddam, 2006).

During MHealth installation at implementation phase, the “Think-Aloud Protocol” was used during which the participant was expected to “speak-out” by vocalising the activities, step by step, while following the installation instructions (Lewis, 1982; Vedanthan et al., 2015).

The researcher listened, observed, recorded the participant’s experiences, digital skills, and “incident encounters” and provided supports during the incident encounters when it was necessary (Lewis, 1982; Vedanthan et al., 2015). Similarly, after the MHealth usage period the ‘role playing’ was used to capture the participant’s demonstration (Vyas, Heylen, Nijholt, & Van Der Veer, 2009). The “role play demonstration was designed to ‘illuminate human interactions, which are situated in practice to discover knowledge that was mainly observed but absent from other documentation (Akama et al., 2007; Suchman, 1987; Vyas et al., 2009).

Both think-aloud protocol (TAP) and role-playing demonstration (RPD) were devised to contextualise the task experiences which the participants carry out naturally as part of their social and environmental interaction with MHealth innovation. The scenario emulates the interactions of the participant with the MHealth tools, programmes, processes, devices and the researcher. The comprehensive data sources ensure that the findings emerging from the evidence are valid and relevant to the participant’s constructions of their lived experiences.

This aspect of the data collection involved memos of direct observation of the individual participants by the researcher. The data collection was conducted during the three phases of MHealth experiences (pre-implementation, implementation and post implementation or usage period). For example, during the MHealth installation the participant’s experiences were recorded, indicating important incidents encounters. Incident encounters and notes were recorded during MHealth ‘think-aloud protocol’ (TAP) and ‘role-play demonstration’ (RPD). Again, the TAP and RPD served as unique data collection tools, which allowed the researcher to capture the participants’ immediate interaction, awareness, and reasoning without depending on delayed description from

memory of previous MHealth narratives. Also, the TAP and RPD tools helped to distil the participant's experiential differences or 'inequalities' during digital MHealth transformation journey, starting - before, during and after implementation which significantly shape the experience that users have with MHealth. Extant literature argues that these measures of inequality are dynamic and underlined by the evolution of the information and network society (DiMaggio & Hargittai, 2001).

It has been noted that patterns of inequality derive from "evolving consequences of interactions among firms' strategic choices, consumers' responses, and government policies" (DiMaggio & Hargittai, 2001). Following the three phases from pre-implementation, implementation, and usage phase of the MHealth we can view the various instances of inequalities along the process. Instances of inequalities or "unfair differences" during MHealth interactions at the field site can be explained as a natural phenomenon and can be conceptualised by analogy, as incident encounters of 'victims of stampede in a global digital rat race' where individuals crash at several stages, and at various levels. This analogy of the digital stampede focus on the crash events or incidents which occur along the "MHealth route" involving the three stages of MHealth (pre-implementation, implementation, and post-usage experience). Also, these digital incidents may relate to any aspect of human endeavours at various levels of intrapersonal, social, and environmental context.

#### *Social Research Ethics Committee (SREC) Approval*

This study was approved by the Social Research Ethics Committee (SREC) of the University College Cork. In compliance with the UCC SREC requirement, a written information document ensuring disclosure and comprehension, competency, voluntariness, confidentiality, and anonymity were given to participant. Also, a written informed consent was obtained from the participant, and a debriefing document was administered at the end of the in-depth interview.

Note also that the information from this activity is anonymous and confidential, and we ensure that the discussion is not personally attributed to the participant, or anyone. The participants were allowed to request additional information for clarification if they wished to do so, or to state any concerns they might have with the process at any time.

### **Operationalisation of MHealth**

#### *The Mobile Health Information Technology (MHealth) Artefacts*

The case of consumer MHealth was operationalised as an innovative technology for physical activity (PA) or exercise by using three MHealth items (Health & Children, 2009). The MHealth for PA study was designed to promote equality, inclusion and diversity in PA participation (DiMaggio & Hargittai, 2001; DiMaggio, Hargittai, Celeste, & Shafer, 2004; Robinson et al., 2015; Weiss et al., 2018).

Details of the operationalisation of MHealth involve the use of: (i) Mobile phone, and (ii) Internet Connection, which were linked through (iii) Health app to (iv) Digital Activity Tracker, and (v) Digital Weighing Scale.

The researcher also carried items for administrative purposes which included the following accessories:

✚ Accessories carried by the Researcher

- Measuring Tape (5 Metre/16ft Measuring Tape (Powerfix))
- AAA Alkaline Batteries (24 Batteries X 3 Packs)
- Digital Voice Recording Device
- Writing materials (including Pen and paper)

✚ The MHealth devices were represented with the following items:

- (i) Participant’s Mobile Phone: A working mobile phone already belonging to the participant.
- (ii) Participant’s Internet connection: A working Internet connection already subscribed by the participant.
- (iii) Sanitas Health-coach app (Sanitas, 2020a)
  - Sanitas health-coach app is a free health app for physical activity (PA) downloadable from online App store using participants' mobile phone
  - Health-Coach app is linked via Bluetooth to 2 devices (Digital PA tracker, and Digital weighing scale) Digital PA tracker, and device
  - Digital Physical Activity tracker with chargers - (Beurer AS80) X 25 items



Figure 1: Mobile Phone, Activity Sensor, and health-coach Cockpit display

(iv) Digital PA tracker device- (Beurer-AS80) (beurer, 2020)

- The digital PA tracker is an activity sensor that records daily activity in steps, duration of sleep and enables the data to be transmitted to the Smartphone via Bluetooth connection.
- Beurer-AS80 device comes with information manuals including Unit description and Quick Set-up guide
- One Digital PA Sensor for each individual of PAB Participant
- Digital bathroom weighing scale (Sanitas-SBF70) X 12 Items



Figure 2: An Example: Beurer-AS 80 Activity Sensor

(v) Digital bathroom weighing scale (Sanitas-SBF70) (Sanitas, 2020b)

- The weighing scale is a bathroom scale that reads health information and enables the data to be transmitted to the Smartphone via Bluetooth connection.
- The Sanitas digital bathroom scale comes with information manuals including Unit description and Quick Set-up guide
- One item of Digital Weighing Scale for each PAB household

Digital PA tracker - (Beurer-AS80) and the Digital bathroom weighing scale (Sanitas-SBF70) are purchased by the researcher with the support of the research institution and given to participant for use in the period of the study.



Figure 3: An Example: Digital Weighing Scale Sanitas-SBF70

Table 1: An Example: Health-coach Health Information Reference Table

**healthcoach**

The colour code is based on the following tables:

**BMI**

Female

Age	Under weight	Normal weight	Over weight	Obesity
10	<14.8	14.8-18.9	19.0-22.5	>22.5
11	<15.3	15.3-19.8	19.9-23.6	>23.6
12	<16.0	16.0-20.7	20.8-24.9	>24.9
13	<16.6	16.6-21.7	21.8-26.1	>26.1
14	<17.2	17.2-22.6	22.7-27.2	>27.2
15	<17.8	17.8-23.4	23.5-28.1	>28.1
16	<18.2	18.2-24.0	24.1-28.8	>28.8
17	<18.4	18.4-24.4	24.5-29.2	>29.2
18	<18.6	18.6-24.7	24.8-29.4	>29.4
19	<18.7	18.7-24.9	25.0-29.6	>29.6
>20	<18.5	18.5-24.9	25.0-29.9	>29.9

Male

Age	Under weight	Normal weight	Over weight	Obesity
10	<14.9	14.9-18.4	18.5-21.3	>21.3
11	<15.3	15.3-19.1	19.2-22.4	>22.4
12	<15.8	15.8-19.8	19.9-23.5	>23.5
13	<16.4	16.4-20.7	20.8-24.7	>24.7
14	<17.0	17.0-21.7	21.8-25.8	>25.8
15	<17.6	17.6-22.6	22.7-26.9	>26.9
16	<18.2	18.2-23.4	23.5-27.8	>27.8
17	<18.8	18.8-24.2	24.3-28.5	>28.5
18	<19.2	19.2-24.8	24.9-29.1	>29.1
19	<19.6	19.6-25.3	25.4-29.6	>29.6
>20	<18.5	18.5-24.9	25.0-29.9	>29.9

**Body fat percentage**

Female

Age	low	Normal	high	Very high
10-14	<16%	16-21%	21.1-26%	>26%
15-19	<17%	17-22%	22.1-27%	>27%
20-29	<18%	18-23%	23.1-28%	>28%
30-39	<19%	19-24%	24.1-29%	>29%
40-49	<20%	20-25%	25.1-30%	>30%
50-59	<21%	21-26%	26.1-31%	>31%
60-69	<22%	22-27%	27.1-32%	>32%
70-100	<23%	23-28%	28.1-33%	>33%

Male

Age	low	Normal	high	Very high
10-14	<11%	11-16%	16.1-21%	>21%
15-19	<12%	12-17%	17.1-22%	>22%
20-29	<13%	13-18%	18.1-23%	>23%
30-39	<14%	14-19%	19.1-24%	>24%
40-49	<15%	15-20%	20.1-25%	>25%
50-59	<16%	16-21%	21.1-26%	>26%
60-69	<17%	17-22%	22.1-27%	>27%
70-100	<18%	18-23%	23.1-28%	>28%

**Body water content**

Female

Age	low	Normal	high
10-100	<45%	45-60%	>60%

Male

Age	low	Normal	high
10-100	<50%	50-65%	>65%

**healthcoach**

Table 2: An Example: Health-coach Health Information Reference Table, Continued

**healthcoach**

**Muscle percentage**

Female

Age	low	Normal	high
10-14	<36%	36-43%	>43%
15-19	<35%	35-41%	>41%
20-29	<34%	34-39%	>39%
30-39	<33%	33-38%	>38%
40-49	<31%	31-36%	>36%
50-59	<29%	29-34%	>34%
60-69	<28%	28-33%	>33%
70-100	<27%	27-32%	>32%

Male

Age	low	Normal	high
10-14	<44%	44-57%	>57%
15-19	<43%	43-56%	>56%
20-29	<42%	42-54%	>54%
30-39	<41%	41-52%	>52%
40-49	<40%	40-50%	>50%
50-59	<39%	39-48%	>48%
60-69	<38%	38-47%	>47%
70-100	<37%	37-46%	>46%

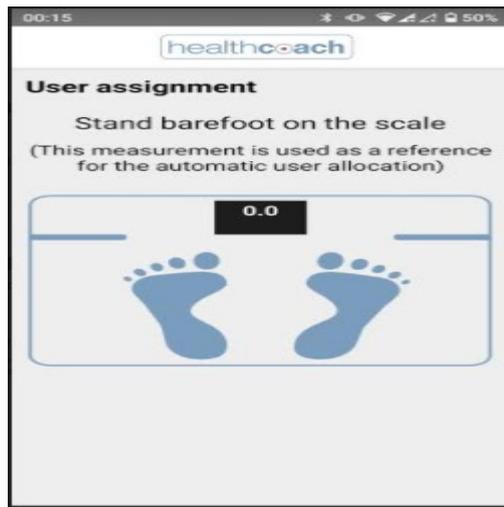


Figure 4: An Example: Showing User's Standing Positions on Digital Scale

## Data Collection using TAP during MHealth Installation

### Introduction to TAP

This section is about direct observation of participant's MHealth installation with 'think-aloud protocol' (TAP). The think-aloud protocol (TAP) was explained but not demonstrated to the participant. During the think-aloud process, the researcher directly observed the participant and noted important incidents and participant's progress. The researcher observed, guided or assisted the participant whenever it became necessary. The participant was expected to "speak-out" by vocalising the activity tasks, step by step, while following the installation instructions. The researcher listened, observed, noted the "incident encounters" and provided supports during the incident encounters when it was necessary (Lewis, 1982; Vedanthan et al., 2015). . The participant began the think-aloud installation while the researcher followed by using the protocol document in this paper.

The MHealth TAP installation protocols include the following.

- The MHealth devices were introduced to the participants
- The think-aloud protocol (TAP) was explained but not demonstrated to the participant
- Researcher directly observed the participant and noted important steps and progress.
  - During installation and setup, the researcher observed, guided, or assisted the participant whenever it became necessary (Lewis, 1982; Vedanthan et al., 2015).

Important Notice -

- *After installation and health data readings from the MHealth data (section 1), participants remained with the MHealth devices as they continued to participate in their exercise*
- *Participant was requested to communicate with researcher whenever they needed support.*

- *Researcher Returned after 8 weeks of MHealth Use Experience to commence individual in-depth, semi structured interviews with each of the 24 PAB from 12 households.*

Executing Think-Aloud MHealth Installation Protocol' (TAP)

The researcher arrived at the participant’s household and followed the interview guide protocol. Firstly, both participants in the household were given the information sheet and allowed the opportunity to read, understand and discuss any details. Following the protocols, the consent form was given to the participants and allowed the opportunity to read, understand, accept or refuse participation. When the consent form was accepted and signed, the researcher collected the demographic data, and then went on to introduce the MHealth devices to the participant.

The participants were given the devices:

- a) Activity tracker (Beurer-AS80), with the ‘Quick Start Guide’ (One item to each participant)
- b) Digital bathroom weighing scale (Sanitas SBF70), with the ‘Quick Start Guide).  
(One item to both participants because it is possible to assign up to 8 users to one digital bathroom weighing scale).

The MHealth devices were introduced to participants to give them a head start.

*Execution: The individual participant session for TAP was designed to last between 25- and 35-minutes period, thus avoiding problems relating to fatigue in TAP protocols (Lewis, 1982; Martin-Rodilla & Gonzalez-Perez, 2016).*

**Table 3. Researcher Noted the Participant's Name, Location, Date and Time of Research Activity**

<b>TITLE</b>	<b>MEMO TABLE</b>	<b>GENDER</b>
<b>NAME OF PARTICIPANT</b>		
<b>RESEARCH ACTIVITY LOCATION</b>	PARTICIPANT’S RESIDENTIAL ADDRESS	
<b>TAP CONDUCTED DATE: DD/MM/YYYY</b>		
<b>RPD CONDUCTED DATE:DD/MM/YYYY</b>		

Table 4: MHealth TAP Installation Tasks (Steps1-13)

INSTALLATION OF MHEALTH (TASK STEPS 1-13)		INCIDENT ENCOUNTER
1	Go to Play Store (on your mobile phone)	
2	Search and select Sanitas- Health-coach app	
3	Install Sanitas Health-Coach (Hans Dinslage GmbH)	
4	Once installed, open the app, and follow the instructions	
5	When prompted- swipe through the tour to the end and click next.	
6	Follow the instruction on the registration page. Add your information (including height in cm when prompted). Click next, and follow the instruction	
7	Click OK when you see the prompt “thank you for registration”	
8	Swipe through to the end of the welcome tour, and click next	
9	Click on “Continue to add a device”	
10	On my device page-Select device – Activity tracker SAS75	
11	Health-coach will request you to turn on Bluetooth connection, click allow and follow the instruction	
12	Health-coach will present you with Settings. Follow the instruction and click next	
13	Health-coach will ask you to activate the activity tracker. Follow the instruction and hold down the button as shown. Allow SAS75 to sync with Health-coach	
	Continue at 14, Next Table	

Table 5: MHealth TAP Installation Tasks (Steps 14-20)

INSTALLATION OF MHEALTH (TASK STEPS 14-20)		INCIDENT ENCOUNTERS
14	Still on Health-coach on your phone Click on the menu button at top left corner And Select Settings	
15	Under my devices section select - add device (it takes you to my devices screen)	
16	From all the devices displayed on screen Select the weighing scale SBF70), (Health-coach will search for the weighing scale)	
17	Health-coach will display the available SBF70. Select the device	
18	Follow the instruction and add new user (with your initials), and select your activity level (from level 1,2,3,4 or 5)	
19	Press next to continue, and follow the instruction	
20	Step on the scale when prompted. SBF70 recognises you and displays your data on app	
	Continue at 21, Next Table	

Table 6: MHealth TAP Installation Tasks (Steps 21-22)

INSTALLATION OF MHEALTH (TASK STEPS 21-27)		Incident encounter	Health data Day 1				Health data Last Day				
21	Record the data on Health-coach and the corresponding colours										
.01	<ul style="list-style-type: none"> <li>Weight in kg</li> </ul>										
			Under weight	Normal weight	Over weight	Obesity					
.02	<ul style="list-style-type: none"> <li>Body mass index BMI</li> </ul>										
.03	<ul style="list-style-type: none"> <li>Read Body Fat</li> </ul>										
.04	<ul style="list-style-type: none"> <li>Read Water</li> </ul>										
.05	<ul style="list-style-type: none"> <li>Muscle</li> </ul>										
22	Close Health-coach App										
	Incidents counts out of the total										
	Time Duration of Think-Aloud										



Figure 5: An Example: Showing User Standing Position, Barefoot to Obtain Health Data for TAP on Day 1

Table 7: An Example: Health-coach Reading of User's Health Data, for TAP on Day 1

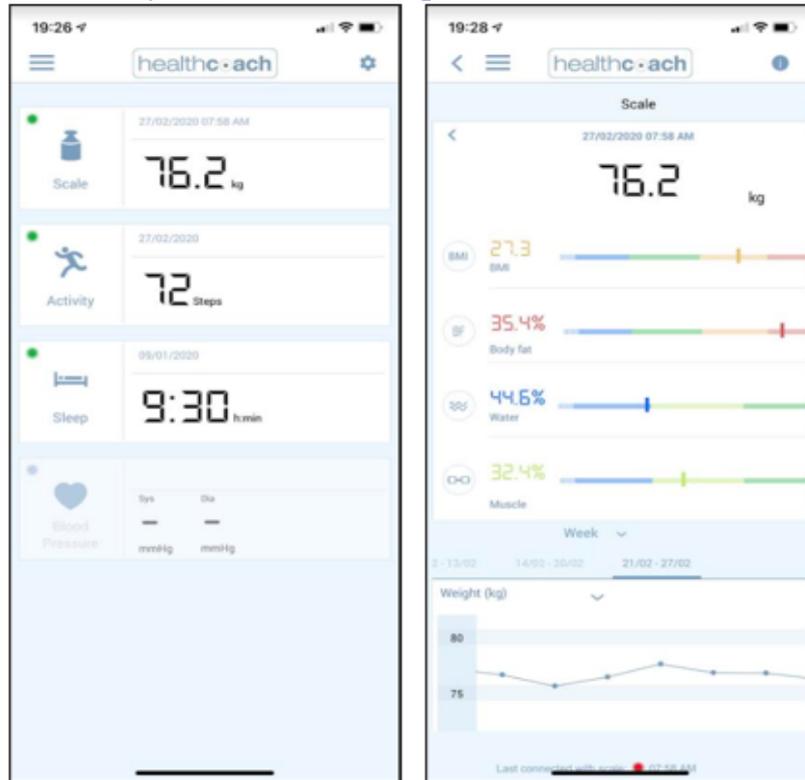


Table 8: Researchers Record of Participants use of TAP (TAP Note 23-35)

	Observed Factors	Note	Don't Know	No	Yes
23	Walkable Neighbourhood for PA				
24	Cyclable Neighbourhood for PA				
25	Indoor household Space for PA				
26	Household help for IT Support				
27	Risk of illness is made observable in colours				
28	Severity of illness is made observable in colours				
.01		Under-Weight			
.02		Normal Weight			
.03		Over-Weight			
.04		Obesity			
29	Whether Health App is easy to use				
30	Health-coach data is motivating for PA				
31	Health App is useful				
32	Participant Showed interest				
33	Participant Made Concerted Effort				
34	IT Self-Efficacy				
35	Participants initial average PA/day	> 3000 steps/day			

End of think-aloud installation

*NOTE: Researcher Returns after 8 weeks of participant's m-health use experience*

## Data Collection Using RPD during Participant’s MHealth Use Demonstration

### Introduction and Execution of RPD

This section lasted about five minutes and was carried out before the in-depth interview began. The RPD involved the direct observation of participant’s demonstration of MHealth use experience by using ‘role playing demonstration’ (RPD). Participant’s ‘role playing’ with MHealth Technology Artefacts and events of the case involving MHealth readings, screenshot photo images of MHealth usage and performance display. The aim of the ‘role playing’ was to “illuminate human interactions, which are situated in practice to discover knowledge that was mainly observed but absent from other documentation (Akama et al., 2007; Suchman, 1987; Vyas et al., 2009).

Reminder:

*“Please note that the information from this activity is anonymous and confidential, and we assure you that the discussion is not personally attributed to you, or anyone. You are allowed to request additional information for clarification if you wish to do so, or to state any concerns you may have at any time”.*

Table 9: Participants RP Demonstration with MHealth (Task Steps 36-44)

INSTALLATION OF MHEALTH (TASK STEPS 1-13)		Incident encounter	Health data Day 1				Health data Last Day			
36	Activate your mobile phone Bluetooth; and Click on health-coach									
37	Stand on the digital weighing scale for your health data update									
38	On the home screen (cockpit) Read your weight in kg									
39	Also read your activity in steps									
40	Click on Scale icon									
41	Record the data on Health-coach and the corresponding colours				-					
.01	o Weight in kg									
.02	o Body mass index BMI									
.03	o Read Body Fat									
.04	o Read Water									
.05	o Muscle									
42	From the drop-down list (Day, Week, Month, Year) - <b>Select Year</b>									
43	Note the current position of the ‘Graphic Display’ Rise or fall									

44	Participants new average PA/day	> 3000 steps/day	un/imp roved PA									
End	Close Health-coach App											
	Time Duration of Think-Aloud											

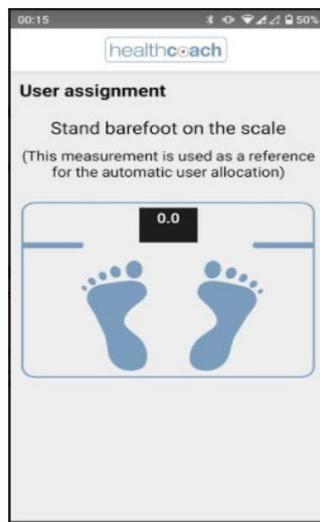


Figure 6: An Example: Participant Stands Barefoot on Digital Scale for RRP Health Data

Table 10: An Example: Health Data Display on Health-coach

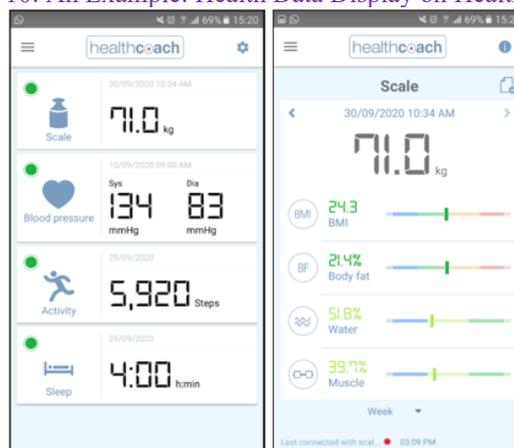


Table 11: An Example: Health Data Display for Activity and Sleep

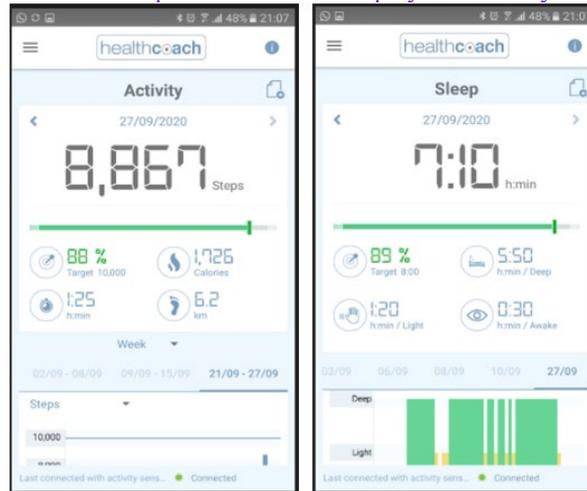


Table 12: An Example: Health-coach Data Display for Weight and Progress for the Month

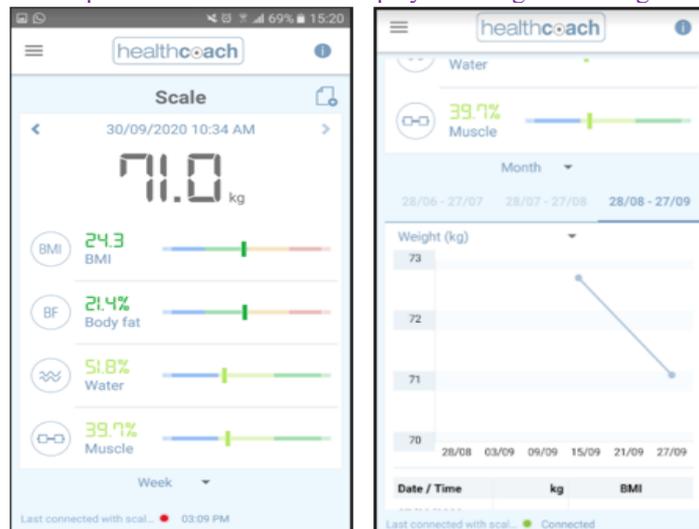


Table 13 Field Report of Observation for Participant's RPD with MHealth (RRP Note 45-62)

	Observed Factors	Note	Not Sure	No	Yes
45	Risk of illness is made observable in colours				
46	Severity of illness is made observable in colours				
.01		Under-Weight			
.02		Normal Weight			
.03		Over-Weight			
.04		Obesity			
47	Whether Health App is easy to use				
48	Has health-coach data motivated you for more physical exercise				
49	health App is useful				
50	Participant Showed interest				
51	Participant Made Concerted Effort				
52	IT Self-Efficacy	improved			

53	Participants popular communication app				
54	Making Progress with PA Target Interest	improved			
55	Was the experience rewarding ( Not Stressful)				
56	Expressed interest to continue with MHealth				
57	Reciprocity for participant participation	was allowed to keep the Activity Tracker AS80			
58	Internet connectivity (MHealth)	Mobile Internet Broadband			
59	Mobile Phone (MHealth)	Android Smartphone:			
60	Function of Health app for physical activity				
61	Function of Activity Sensor				
62	Function of Digital weighing scale (MHealth)				

## Report of TAP and RPD Observation of Participant by the Researcher

### Participant’s Incident Report (Participant’s Code Identity Inserted Here)

Incident encounters and notes were recorded during MHealth ‘think-aloud protocol’ (TAP) and ‘role-play protocol’ (RPD). The TAP and RPD served as unique data collection tools, which allowed the researcher to capture the participants’ immediate interaction, awareness, and reasoning without depending on delayed description from memory of previous MHealth narratives. Unless research participants are extremely insightful, they might not know or remember all the rationale for their behaviour or reasons why they do things (Strauss & Corbin, 1998). Also, the TAP and RPD tools helped to distil the participant’s experiential differences or ‘inequalities’ during digital MHealth transformation journey, starting - before, during and after implementation which significantly shape the experience that users have with MHealth. Again, the researcher entered the field without a preconceived notion, and with original insight which necessitated the use of TAP and RPD to capture information, because there was no preconception or even existence hypothesis of the area of study before entering the field (Goulding, 1999; Moghaddam, 2006).

Also note that prior to MHealth implementation the participant was encouraged and equipped with the MHealth artefacts. Ownership of mobile telephone and internet connection were prerequisites (see demographic data), the Health coach app was downloaded, and MHealth devices were supplied to the participant which include “Activity Sensor, Beurer-AS80, and digital weighing Scale Sanitas-SBF70”. These resources enable access to the various services provided by MHealth.

### INCIDENT ENCOUNTERS WITH MHEALTH DURING TAP (STEPS 1-22)

#### Step 1

Go to Play Store (on your mobile phone)

#### Step 2

Search and select Sanitas- Health-coach app

#### Step 3

Install Sanitas Health-Coach (Hans Dinslage GmbH)

#### Step 4

Once installed, open the app, and follow the instructions

#### Step 5

When prompted- swipe through the tour to the end and click next.

#### Step 6

Follow the instruction on the registration page. Add your information (including height in cm when prompted).

Click next, and follow the instruction

#### Step 7

Click OK when you see the prompt “thank you for registration”

#### Step 8

Swipe through to the end of the welcome tour, and click next

#### Step 9

Click on “Continue to add a device”

#### Step 10

On my device page-Select device – Activity tracker SAS75

#### Step 11

Health-coach will request you to turn on Bluetooth connection, click allow and follow the instruction

#### Step 12

Health-coach will present you with Settings. Follow the instruction and click next

#### Step 13

Healthcoach will ask you to activate the activity tracker. Follow the instruction and hold down the button as shown. Allow SAS75 to sync with Health-coach.

#### Step 14

Still on Healthcoach on your phone. Click on the menu button at top left corner. And Select Settings

#### Step 15

Under my devices section select - add device (it takes you to my devices screen)

#### Step 16

From all the devices displayed on screen. Select the weighing scale SBF70),

(Health-coach will search for the weighing scale)

Step 17

Healthcoach will display the available SBF70. Select the device

Step 18

Follow the instruction and add new user (with your initials), and select your activity level (from level 1,2,3,4 or 5)

Step 19

Press next to continue, and follow the instruction

Step 20

Step on the scale when prompted, SBF70 recognises you and displays your data on app

Step 21

Record the data on Health-coach and the corresponding colours

- .01 Weight in kg
- .02 Body mass index BMI
- .03 Read Body Fat
- .04 Read Water
- .05 Muscle

Step 22

Close Health-coach App.

Incidents counts out of the total

Time Duration of Think-Aloud

#### INCIDENTS EXTRACTED FROM RPD NOTES (STEPS 45-57)

Step 23-25

Walkable Neighbourhood for PA

Step 24

Cyclable Neighbourhood for PA

Step 25

Indoor household Space for PA

Step 26

Household help for IT Support

Step 27

Risk of illness is made observable in colours

Step 28

Severity of illness is made observable in colours

.01 Under-Weight

.02 Normal Weight

.03 Over-Weight

.04 Obesity

Step 29

Whether Health App is easy to use

Step 30

Healthcoach data is motivating for PA

Step 31

Health App is useful

Step 32

Participant Showed interest

Step 33

Participant Made Concerted Effort

Step 34

Self-Efficacy in IT

Step 35

Participants initial average PA/day

INCIDENT ENCOUNTERS WITH M-HEALTH DURING RPD (TASK STEPS 36-44)

Step 36-40

Activate your mobile phone Bluetooth; and Click on health-coach

Step 37

Stand on the digital weighing scale for your health data update

Step 38

On the home screen (cockpit) Read your weight in kg

Step 39

Also read your activity in steps

Step 40

Click on Scale icon

Step 41

Record the data on Health-coach and the corresponding colours

- .01 Weight in kg
- .02 Body mass index BMI
- .03 Read Body Fat
- .04 Read Water
- .05 Muscle

Step 42

From the drop-down list. (Day, Week, Month, Year) - Select Year

Step 43

Note the current position of the 'Graphic Display' Rise or fall

Step 44

Participant's final average PA/day

Close Healthcoach App

Time Duration of Think-Aloud

INCIDENTS EXTRACTED FROM RPD NOTES (STEPS 45-57)

Step 45

Risk of illness is made observable in colours

Step 46

Severity of illness is made observable in colours

- .01 Under-Weight

.02 Normal Weight

.03 Over-Weight

.04 Obesity

Step 47

Whether Health App is easy to use

Step 48

Has your health-coach data motivated you for more physical exercise?

Step 49

The health App is useful

Step 50

Participant Showed interest

Step 51

Participant Made Concerted Effort

Step 52

Self-Efficacy in IT

Step 53

Participant's popular communication app

Step 54

Making Progress with PA Target Interest

Step 55

MHealth experience rewarding or Stressful?

Step 56

Expressed interest to continue with MHealth

Step 57

MHealth research participation and Reciprocity

Step 58

Internet connectivity (MHealth)

Step 59

Mobile Phone (MHealth)

Step 60

Health-coach app

Step 61

Activity Sensor

Step 62

Digital weighing scale (MHealth)

Step 63

Further notes

## **APPENDIX G: Interview Questions**

1.0 How would you generally describe your health status at present? Please, choose from the following (1. Don't Know; 2. Not Good, 3. Good; 4. Very Good)

1.1 What do you understand as the risks associated with lack of exercise or sedentary lifestyle, i.e., sitting in a place for a very long time?

1.2 Please can you tell us about your daily routines, especially how busy you are and how much time you spend on physical exercise daily?

2.0 In what ways did you use this Mobile Health system (i.e. activity tracker on your wrist, weighing scale and health-coach app on your phone) to monitor your daily exercises?

2.1 In what ways did the health-coach system support your exercise, especially with members of your family, even in a discussion or conversation?

2.2 In what ways did this health-coach app support your exercise in relation with friends or community outside your family?

2.3 What do you recall as key usefulness of the health-coach app, i.e. what things the App help you do which you could not do without the App?

3.0 From when you started using the Mobile Health, what improvement have you made on the time you spend on your daily exercise?

3.1 Based on the health Coach reading on your phone, what improvement have you observed on the Colour Charts for the Body mass index BMI, body fat percentage, body water content, muscle percentage?

4.0 Have you developed interest for health Apps? If yes why; if no why not?

4.1 Now that you have used the App, how easy was it to use at the beginning and now the end, in terms of time, effort, skills needed for health coach.

4.2 How easy was it to observe and understand the result of your physical exercise from the health app on your mobile phone?

5.0 Despite the popularity of mobile health devices, it is surprising that some people, maybe you did not use them for the benefit of your health and wellbeing. Before the introduction of this App to you, what was your reasons for not using any mobile health App?

5.1 Do these obstacles still exist?

6.0 Considering what you know now, what do you perceive as the importance of the use of Mobile Health for you, and for your family, perhaps?

6.1 How seriously would you take this App if it was approved by the National Health Service provider to serve as your health coach, guiding you, encouraging and supporting you?

7.0 What do you recall as key problems, challenges or worries when you used the mobile health system i.e. what can be improved to enable you do more exercise?

7.1 Did the app interfere or disturb your routines or usual way of doing things

FLAG OTHER SOURCES OF INEQUITIES

8.0 In this society there are individuals who get better access to medical care because they have good health insurance. What is your opinion about better medical care given to some individuals but not everyone?

8.1) Do you follow the national politics and voting in general elections? If yes, why; or why not, if you don't?

9.0 What other recommendations do you have to improve the use of Mobile Health for physical exercise, especially for families like yours?

9.1 Do you have any other information to share in this interview?

Thank you for your participation in our study!

END OF INTERVIEW

## APPENDIX H: Debriefing for Research Participants

**Research Title:** Mobile-Health Equitable Remedy - Investigating the antecedents of health inequalities associated with m-health usage behaviour of the ethnic minority population.

**Thank you for your participation in our study! Your participation is greatly appreciated.**

**Purpose of the Study:** We previously informed you that the purpose of this study on “Mobile-Health Equitable Remedy” was to investigate the antecedents of health inequality associated with m-health usage behaviour of ethnic minority population.

### **The Research Goal**

The goal of our research is to promote equality, diversity and inclusion in the use of digital health devices for minority populations.

**Confidentiality:** Your confidentiality is assured as detailed on the information sheet which you have read. However, you may decide that you do not want your data used in this research. If you would like your data removed from the study and permanently deleted, this can be done within 2 weeks after your interview. You should contact the researcher, the supervisors, or the University College Cork.

### **Useful Contact Information:**

- *Rowland Njoku (Researcher)* Phone: + 353 851091919 E-mail: [rownjoku@gmail.com](mailto:rownjoku@gmail.com)
- *Professor Frederic Adam (Supervisor)*, Phone: +353 214903343 E-mail: [FAdam@ucc.ie](mailto:FAdam@ucc.ie)
- *Dr. Simon Woodworth (Supervisor)*, Phone: +353 214903830 Email: [s.woodworth@ucc.ie](mailto:s.woodworth@ucc.ie)
- *The HOD, BIS, UCC.* Phone: +353 (0)21 4903829 Email: [bis@ucc.ie](mailto:bis@ucc.ie)

### **Further Information**

If you would like to receive a copy of the final report of this study (or a summary of the findings) when it is completed, please feel free to contact us.

## APPENDIX I: Debriefing Form for Research Participants

If you have any questions or concerns regarding this study, its purpose or procedures, or if you have a research-related problem, please feel free to contact the researcher.

If you have any questions concerning your rights as a research subject, you may contact the Irish Human Rights and Equality Commission (IHREC): Phone: 18589601, Email: [info@ihrec.ie](mailto:info@ihrec.ie)

If you feel upset after having completed the study or find that some questions or aspects of the study triggered a distress, talking with a qualified clinician may help. If you feel you would like assistance, please contact your GP. *[In a serious emergency, remember that you can also call 999, or 112, which are the standard medical emergency numbers for immediate assistance.]*

**Further Reading(s):** If you would like to learn more about the study on “M-Health Equitable Remedy” please contact the researcher for the research references:

**Please keep a copy of this form for your future reference. Once again, thank you for your participation in this study!**

## APPENDIX J: Screenshot of NVivo QDAS Nodes.

The screenshot displays the NVivo QDAS Nodes interface. The top menu bar includes File, Home, Import, Create, Explore, and Share. The main workspace shows a hierarchical tree of nodes on the left and a table of node statistics on the right.

Name	Files	References
ANTECEDENTS OF INEQUALITIES IN CONSUMER MHEALTH		0
1.0 M-HEALTH SYSTEM INEQUALITY IS A MEASURE OF DIFFERENCES OR VARIATIONS IN		30
1.1 Consumer Access to mHealth or physical availability of mHealth essentials		26
1.1.1 consumer access to internet connection		6
1.1.2 consumer awareness of mHealth- Smartphone, Mobile health app, Weighing scale, Activity sensor		17
1.1.3 consumer access to mHealth- Smartphone, Mobile health app, Weighing scale, Activity sensor		17
1.2 Suitability of mHealth equipment to meet personal need		24
1.2.1 suitability of internet connection		2
1.2.2 suitability of mHealth devices		23
1.2.3 suitability of mHealth software applications		12
1.3 Autonomy of mHealth equipment as to the level of control it allows		11
1.3.1 autonomy of internet connection		3
1.3.2 autonomy of mHealth digital devices- Smartphone , weighing scale, activity sensor		7
1.3.3 autonomy of mHealth software applications		2
2.0 UTILISATION INEQUALITY IN MHEALTH- TRADITIONAL SILO MHEALTH, AS MEASURE OF DIFFERENCES DU		29
2.1 Demographic and Socioeconomic Variables		12
2.2 Inequality in the consumer perceived benefits of mHealth in terms of		29
2.3 consumer perceived constraint		18
3.0 INEQUALITY IN INTERACTIVE MHEALTH COMMUNICATION WAS PREDICTED BY VARIATION IN		30
3.1 mHealth advocacy to promote physical activity and fitness		14
3.2 Social Network as web of social relationships that surround individuals		12
3.3 Social Support include direct and indirect assistance available from other sources		28

## APPENDIX K: Data Analysis Concepts and Categories 1

SAMPLE OPEN CODING USED DURING DATA ANALYSIS BASED ON INTERVIEW TRANSCRIPT, TAP AND RPP INCIDENT REPORTS	Open Code
1.1.1 availability and cost of internet connection; 1.1.2 availability and cost of mHealth digital devices (Smartphone, W	
1.1.1 availability and cost of internet connection; 1.1.2 availability and cost of mHealth digital devices (Smartphone, W	
<p><b>What do you recall as key problems, challenges or concerns with the usage of the app or</b>  <b>08. CORK 4.2 A</b>            So I think once you have internet you're able to use it</p>	internet connection
<b>TAP AND RPP INCIDENT REPORT</b>	
<p><b>23. DUBLIN 12.1</b>            Ownership of Smartphone and internet connection were prerequisites</p>	ownership of digital devices such as Smartphone, weighing scale, activity sensor
<b>Healthcoach app description</b>	
<p><b>01. CORK 1.1 INCIDENT REPORT</b>            Whether you are on holiday, business trip or at the doctor, the application allows you to always view and track your values. Switch easily between weight, blood pressure, activity and sleep</p>	mobile software app
<b>Do these obstacles still exist for you to use mHealth?</b>	
<p><b>21 DUBLIN 11.1</b>            Such obstacles still exist because if something, its just like the health people telling us to go in the direction of eating healthy, but when you go to the supermarket, most of the things that are supposed to be healthy things are the most expensive. So they are not very cheap for people to access. So if things are made easier for people like commoners like us, to be able to</p>	affordability of devices
<b>How seriously, would you take this app if it was approved by the National Health Service Provider to serve as your health coach guiding you encourage Virgin and supporting you.</b>	
<p><b>08. CORK 4.2</b>            I would use it. I would probably buy it if I could afford it, but I'd use. Yes, I would definitely buy it if it was beneficial because it's set to be, you know, really good for you. But the only problem is I, I probably wouldn't be the same. I might not use it as much just because I think it's like a little bit more expensive and a lot of people my age probably don't, I don't know, have the income for that or have like the time to be spending a lot of money on that. Basically, if it was approved by health service, I would definitely take it more seriously, as it's just proven to be</p>	affordability of devices
<b>Do you have any other information to share in this interview?</b>	
<p><b>11 GALWAY 6.1</b>            Well, the information I will I will share is like if some of this a health coach and all the app and, you know, if it can be if it's something that can that can be made affordable to families, it will be of a great help. Because I remember that even when I got that even my daughter and my son, they were much interested in getting their own. Of which I told them I'm not ready at the moment, I haven't got the money. And they have been disturbing me. But if it's something that</p>	affordability of device by family users
<p><b>23. DUBLIN 12.1</b>            The only information I need to share is that I need to keep this (ie to retain the mHealth device)</p>	free access to devices
<b>Despite the popularity of mobile devices, it is surprising that you did not use them for the benefit of your health and well-being being. Before the introduction of this app to you, what was your reasons for not using any mobile health apps?</b>	
<p><b>21 DUBLIN 11.1</b>            Well, I would say the first thing is this one came easy, it was free. Which means if health can be made accessible to people and make cheap enough it will encourage A lot of people to get into it. So for me, I have never considered any app to be able to help me to improve my</p>	free access to devices

## APPENDIX L: Data Analysis Concepts and Categories 2

Open Code	in the mHealth context the concept is:	Commonality	Category
			Measures of differences in the "IS" characteristics (Technology system, people, information and communication processes) are used as templates to put the codes in context.
			MHEALTH SYSTEM INEQUALITY
devices (Smartphone, W	<b>Consumer Access to mHealth</b>	MHEALTH SYSTEM INEQUALITY was predicted by Consumer Access to mHealth	
internet connection	internet connection is a requirement to access mHealth	consumer access to mHealth was predicted by access to internet connection	<b>consumer Access to mHealth</b>
ownership of digital devices such as Smartphone, weighing scale, activity sensor	ownership of digital devices such as Smartphone, weighing scale, activity sensor for	consumer access to mHealth was predicted by ownership of digital devices such as Smartphone, weighing scale,	<b>consumer Access to mHealth</b>
mobile software app	mobile software app for access to mHealth	user access to mHealth was predicted by mobile software app	consumer Access to mHealth
affordability of devices	affordability of devices for access to mHealth	consumer access to mHealth was predicted by affordability of devices	consumer Access to mHealth
affordability of devices	affordability of devices for access to mHealth	consumer access to mHealth was predicted by affordability of devices	consumer Access to mHealth
affordability of device by family users	affordability of device by family users for access to mHealth	consumer access to mHealth for family was predicted by affordability of device by family users	consumer Access to mHealth
free access to devices	free access to devices for access to mHealth	consumer access to mHealth was predicted by free access to devices	consumer Access to mHealth
free access to devices	free access to devices for access to mHealth	consumer access to mHealth was predicted by free access to devices	consumer Access to mHealth

# APPENDIX M: QDA Nodes of Concepts, Commonality, and Category

		MHEALTH EQUITABLE REMEDY Exploring the determinants of inequalities in consumer mHealth information for physical activity and fitness promotion			Measures of differences in the "IS" characteristics (Technology system, people, information and communication processes) are used as coding templates to interrogate, analyse or cross-examine the EMAB data			
		SAMPLE OPEN CODING USED DURING DATA ANALYSIS						
		BASED ON INTERVIEW TRANSCRIPT, TAP AND RPP INCIDENT REPORTS	Open Code (concept or theme)	the Context	Commonality			Category
1.0	MHEALTH SYSTEM INEQUALITY	a measure of differences or level of						MHEALTH SYSTEM INEQUALITY
1.1	Consumer Access to mHealth	1.1.1 availability and cost of internet connection; 1.1.2 availability and cost of mHealth digital devices (Smartphone, Weighing scale, Activity sensor); 1.1.3 availability and cost of mHealth	Consumer Access to mHealth		MHEALTH SYSTEM INEQUALITY was predicted by Consumer Access to mHealth			
1.1.1	Internet connection	Q7.0 What do you recall as key problems, challenges or concerns with the usage of the app or similar health innovation technologies? 08. CORK 4.2 AMARA UCHENA So I think once you have internet you're able to use it	Internet connection	Internet connection is a requirement to access mHealth	Consumer access to mHealth was predicted by access to internet connection			Consumer Access to mHealth
	TAP and RPD Report page 3	Operationalisation of mHealth with TAP AND RPP INCIDENT REPORT page 3 Participant: 02. CORK 1.2 SHANNON ERIC Details of the operationalisation of mHealth for installation, access and usage involve the following: (i) Access to Smartphone, and (ii) Access to Internet Connection, (iii) Access to Mobile health app (iv) Access to Digital Activity Tracker, and (v) Access to Digital Weighing Scale.						
	TAP	TAP AND RPP INCIDENT REPORT						
1.1.2	ownership of digital devices such as Smartphone, weighing scale, activity sensor	23. DUBLIN 12.1 NAGOZY AMARA Ownership of Smartphone and internet connection were prerequisites	ownership of digital devices such as Smartphone, weighing scale, activity sensor	ownership of digital devices such as Smartphone, weighing scale, activity sensor for access to mHealth	Consumer access to mHealth was predicted by ownership of digital devices such as			✓
	TAP and RPD Report page 2	TAP AND RPP INCIDENT REPORT						
	Operationalisation of mHealth installation, Access and Usage with TAP	This aspect of the data collection involved records of direct observation of mHealth access and usage of the individual participants by the researcher. The data collection was conducted during the three phases of mHealth installation, access and usage experiences (at pre-implementation, implementation and post implementation). For example during the mHealth installation, access and usage the participant's experiences were recorded, indicating important incidents/encounters, using "think-aloud protocol" (TAP). Incident encounters and notes were						
	TAP and RPD Report page 13	sec 4 Data collection using RPD page 12 This section lasted about five minutes and was carried out before the in-depth interview began. The "role play demonstration (RPD)" involved the direct observation of participant's demonstration of the access to mHealth and usage experience by using RPD. Participant's demonstrated their						
	mHealth installation, access and usage during Data Collection with RPD	Details of the operationalisation of mHealth for installation, access and usage involve the following: (i) Access to Smartphone, and (ii) Access to Internet Connection, (iii) Access to Mobile health app (iv) Access to Digital Activity Tracker, and (v) Access to Digital Weighing Scale.						
	Step 60	Healthcoach app description						
1.1.3	mobile software app	01. CORK 1.1 JOMBOS ERIC, INCIDENT REPORT Whether you're on holiday, business trip or at the doctor, the application allows you to always view and track your values. Switch easily between weight, blood pressure, activity and sleep. 09.1 How does obtaining an app with you use mHealth? 21 DUBLIN 11.1 OLUCHI CHRISTIE Yes, such obstacles still exist because if something, its just like the health people telling us to go in the direction of eating healthy, but when you go to the supermarket, most of the things that are supposed to be healthy things are the most expensive. So they are not very cheap for people to access. So if things are made easier for people like commoners like us, to be able to get through to them. Of course lots of people will jump at it. 09.1 How seriously would you use this app if it was approved by the National Health Service Provider to serve as your health coach guiding you encourage Virgin and supporting you? 08. CORK 4.2 AMARA UCHENA I would use it. I would probably buy it if I could afford it, but I'd use. Yes, I would definitely buy it if it was beneficial because it's set to be, you know, really good for you. But the only problem is I, probably wouldn't be the same. I might not use it as much just because I think it's like a little bit more expensive and a lot of people my age probably don't, I don't know, have the income for that or have like the time to be spending a lot of money on that. Basically, if it was approved by health service, I would definitely take it more seriously, as it's just proven to be generally more beneficial to users than most of the other ones.	mobile software app	mobile software app for access to mHealth	User access to mHealth was predicted by mobile software app			✓
	affordability of devices	09.1 How seriously would you use this app if it was approved by the National Health Service Provider to serve as your health coach guiding you encourage Virgin and supporting you? 08. CORK 4.2 AMARA UCHENA I would use it. I would probably buy it if I could afford it, but I'd use. Yes, I would definitely buy it if it was beneficial because it's set to be, you know, really good for you. But the only problem is I, probably wouldn't be the same. I might not use it as much just because I think it's like a little bit more expensive and a lot of people my age probably don't, I don't know, have the income for that or have like the time to be spending a lot of money on that. Basically, if it was approved by health service, I would definitely take it more seriously, as it's just proven to be generally more beneficial to users than most of the other ones.	affordability of devices	affordability of devices for access to mHealth	Consumer access to mHealth was predicted by affordability of devices			Consumer Access to mHealth
	affordability of devices	09.1 How seriously would you use this app if it was approved by the National Health Service Provider to serve as your health coach guiding you encourage Virgin and supporting you? 08. CORK 4.2 AMARA UCHENA I would use it. I would probably buy it if I could afford it, but I'd use. Yes, I would definitely buy it if it was beneficial because it's set to be, you know, really good for you. But the only problem is I, probably wouldn't be the same. I might not use it as much just because I think it's like a little bit more expensive and a lot of people my age probably don't, I don't know, have the income for that or have like the time to be spending a lot of money on that. Basically, if it was approved by health service, I would definitely take it more seriously, as it's just proven to be generally more beneficial to users than most of the other ones.	affordability of devices	affordability of devices for access to mHealth	Consumer access to mHealth was predicted by affordability of devices			✓
	affordability of device by family users	09.1 How seriously would you use this app if it was approved by the National Health Service Provider to serve as your health coach guiding you encourage Virgin and supporting you? 08. CORK 4.2 AMARA UCHENA I would use it. I would probably buy it if I could afford it, but I'd use. Yes, I would definitely buy it if it was beneficial because it's set to be, you know, really good for you. But the only problem is I, probably wouldn't be the same. I might not use it as much just because I think it's like a little bit more expensive and a lot of people my age probably don't, I don't know, have the income for that or have like the time to be spending a lot of money on that. Basically, if it was approved by health service, I would definitely take it more seriously, as it's just proven to be generally more beneficial to users than most of the other ones.	affordability of device by family users	affordability of device by family users for access to mHealth	Consumer access to mHealth for family was predicted by affordability of device by family users			✓
	free access to devices	23. DUBLIN 12.1 NAGOZY AMARA The only information I need to share is that I need to keep this (to retain the mHealth device). 09.0 Despite the popularity of mobile devices, it is surprising that you did not use them for the benefit of your health and well-being before. Before the introduction of this app to you, what was your reasons for not using any mobile health app? 21 DUBLIN 11.1 OLUCHI CHRISTIE Well, I would say the first thing is this one came easy, it was free. Which means if health can be made accessible to people and make cheap enough it will encourage a lot of people to get into it. So for me, I have never considered any app to be able to help me to improve my lifestyle until I came in touch with this. And because it was free, it didn't cost me anything.	free access to devices	free access to devices for access to mHealth	Consumer access to mHealth was predicted by free access to devices			✓
1.1.4	awareness	09.0 Despite the popularity of mobile devices, it is surprising that you did not use them for the benefit of your health and well-being before the introduction of this app to you, what was your reasons for not using any mobile health app? 05. CORK 3.1 THEOWOMA Ignorance, so many people aren't aware of, of such app. So many people are not aware that they could, you know, be able to help themselves from their comfort zone. So, if people will be aware of it, I think it will help so much 02. CORK 1.2 SHANNON ERIC Apps? I just didn't know that much about them. And they seemed like expensive, and that it didn't help that much. And I didn't really understand how it worked and things but now that I'm using it, I think it's a good app 11 GALWAY 6.1 KEN ORAM Sometimes I hear people talk about it, but I never thought of it. And I don't think it's something that is serious you know. And I will say that I didn't develop interest until I was introduced to this particular one. And I now realize the benefit of that, you know, and it's something that I would like to keep up with, yeah. 15 GALWAY 8.1 OKY NCK I never heard about them. So you were the first one that told me about them. If you could recall, how surprised I was at the app. So you brought it to my notice, I never knew. I will say communication gap, and marketing, you know, maybe based on the target of our population, I don't know, or the population or the age bracket, or the work. So I don't know why it's not there. It's not there, but I did not hear about it. And I think a lot of people didn't hear about it. And if they should, and if they were told very aware maybe from professionals, or those who know more than I do in the fields about the importance of that how important they are to the health, I think they will be happy to jump on the bandwagon as I did. 06. CORK 3.2 KATE EWOMA Before now, I don't see any importance of it because you can't know the importance of what you don't know. So now I see the importance of it, how helpful it is to have. How to help you to monitor your health, health levels. Especially how to deal with cardiac health, like exercise helps in cardiac health. The awareness and understanding is better off now than before. Q1.1 What do you understand as the risk associated with lack of exercise or sedentary lifestyle, that is sitting in a place for a long time. You can narrate from here now. 23. DUBLIN 12.1 NAGOZY AMARA Sitting in a place for a long time or lack of exercise can cause one to be obese. It can also trigger some risk factors associated with maybe diabetes or high blood pressure and then so it is very, very you know, good for someone to actually put in at least 30 minutes a day, as part of exercise just to keep fit, even when you think you're very healthy, or you're healthy.	free access to devices	free access to devices for access to mHealth	Consumer access to mHealth was predicted by free access to devices			✓
1.1.4	awareness	09.0 Despite the popularity of mobile devices, it is surprising that you did not use them for the benefit of your health and well-being before the introduction of this app to you, what was your reasons for not using any mobile health app? 05. CORK 3.1 THEOWOMA Ignorance, so many people aren't aware of, of such app. So many people are not aware that they could, you know, be able to help themselves from their comfort zone. So, if people will be aware of it, I think it will help so much 02. CORK 1.2 SHANNON ERIC Apps? I just didn't know that much about them. And they seemed like expensive, and that it didn't help that much. And I didn't really understand how it worked and things but now that I'm using it, I think it's a good app 11 GALWAY 6.1 KEN ORAM Sometimes I hear people talk about it, but I never thought of it. And I don't think it's something that is serious you know. And I will say that I didn't develop interest until I was introduced to this particular one. And I now realize the benefit of that, you know, and it's something that I would like to keep up with, yeah. 15 GALWAY 8.1 OKY NCK I never heard about them. So you were the first one that told me about them. If you could recall, how surprised I was at the app. So you brought it to my notice, I never knew. I will say communication gap, and marketing, you know, maybe based on the target of our population, I don't know, or the population or the age bracket, or the work. So I don't know why it's not there. It's not there, but I did not hear about it. And I think a lot of people didn't hear about it. And if they should, and if they were told very aware maybe from professionals, or those who know more than I do in the fields about the importance of that how important they are to the health, I think they will be happy to jump on the bandwagon as I did. 06. CORK 3.2 KATE EWOMA Before now, I don't see any importance of it because you can't know the importance of what you don't know. So now I see the importance of it, how helpful it is to have. How to help you to monitor your health, health levels. Especially how to deal with cardiac health, like exercise helps in cardiac health. The awareness and understanding is better off now than before. Q1.1 What do you understand as the risk associated with lack of exercise or sedentary lifestyle, that is sitting in a place for a long time. You can narrate from here now. 23. DUBLIN 12.1 NAGOZY AMARA Sitting in a place for a long time or lack of exercise can cause one to be obese. It can also trigger some risk factors associated with maybe diabetes or high blood pressure and then so it is very, very you know, good for someone to actually put in at least 30 minutes a day, as part of exercise just to keep fit, even when you think you're very healthy, or you're healthy.	awareness	awareness of mHealth	Consumer access to mHealth was predicted by awareness of mHealth			Consumer Access to mHealth
	knowledge and understanding	02. CORK 1.2 SHANNON ERIC Apps? I just didn't know that much about them. And they seemed like expensive, and that it didn't help that much. And I didn't really understand how it worked and things but now that I'm using it, I think it's a good app 11 GALWAY 6.1 KEN ORAM Sometimes I hear people talk about it, but I never thought of it. And I don't think it's something that is serious you know. And I will say that I didn't develop interest until I was introduced to this particular one. And I now realize the benefit of that, you know, and it's something that I would like to keep up with, yeah. 15 GALWAY 8.1 OKY NCK I never heard about them. So you were the first one that told me about them. If you could recall, how surprised I was at the app. So you brought it to my notice, I never knew. I will say communication gap, and marketing, you know, maybe based on the target of our population, I don't know, or the population or the age bracket, or the work. So I don't know why it's not there. It's not there, but I did not hear about it. And I think a lot of people didn't hear about it. And if they should, and if they were told very aware maybe from professionals, or those who know more than I do in the fields about the importance of that how important they are to the health, I think they will be happy to jump on the bandwagon as I did. 06. CORK 3.2 KATE EWOMA Before now, I don't see any importance of it because you can't know the importance of what you don't know. So now I see the importance of it, how helpful it is to have. How to help you to monitor your health, health levels. Especially how to deal with cardiac health, like exercise helps in cardiac health. The awareness and understanding is better off now than before. Q1.1 What do you understand as the risk associated with lack of exercise or sedentary lifestyle, that is sitting in a place for a long time. You can narrate from here now. 23. DUBLIN 12.1 NAGOZY AMARA Sitting in a place for a long time or lack of exercise can cause one to be obese. It can also trigger some risk factors associated with maybe diabetes or high blood pressure and then so it is very, very you know, good for someone to actually put in at least 30 minutes a day, as part of exercise just to keep fit, even when you think you're very healthy, or you're healthy.	knowledge and understanding	knowledge and understanding of mHealth	Consumer access to mHealth was predicted by knowledge and understanding of mHealth			✓
	information	11 GALWAY 6.1 KEN ORAM Sometimes I hear people talk about it, but I never thought of it. And I don't think it's something that is serious you know. And I will say that I didn't develop interest until I was introduced to this particular one. And I now realize the benefit of that, you know, and it's something that I would like to keep up with, yeah. 15 GALWAY 8.1 OKY NCK I never heard about them. So you were the first one that told me about them. If you could recall, how surprised I was at the app. So you brought it to my notice, I never knew. I will say communication gap, and marketing, you know, maybe based on the target of our population, I don't know, or the population or the age bracket, or the work. So I don't know why it's not there. It's not there, but I did not hear about it. And I think a lot of people didn't hear about it. And if they should, and if they were told very aware maybe from professionals, or those who know more than I do in the fields about the importance of that how important they are to the health, I think they will be happy to jump on the bandwagon as I did. 06. CORK 3.2 KATE EWOMA Before now, I don't see any importance of it because you can't know the importance of what you don't know. So now I see the importance of it, how helpful it is to have. How to help you to monitor your health, health levels. Especially how to deal with cardiac health, like exercise helps in cardiac health. The awareness and understanding is better off now than before. Q1.1 What do you understand as the risk associated with lack of exercise or sedentary lifestyle, that is sitting in a place for a long time. You can narrate from here now. 23. DUBLIN 12.1 NAGOZY AMARA Sitting in a place for a long time or lack of exercise can cause one to be obese. It can also trigger some risk factors associated with maybe diabetes or high blood pressure and then so it is very, very you know, good for someone to actually put in at least 30 minutes a day, as part of exercise just to keep fit, even when you think you're very healthy, or you're healthy.	information about mHealth	information about access to mHealth	Consumer access to mHealth was predicted by information about mHealth			✓
	communication	15 GALWAY 8.1 OKY NCK I never heard about them. So you were the first one that told me about them. If you could recall, how surprised I was at the app. So you brought it to my notice, I never knew. I will say communication gap, and marketing, you know, maybe based on the target of our population, I don't know, or the population or the age bracket, or the work. So I don't know why it's not there. It's not there, but I did not hear about it. And I think a lot of people didn't hear about it. And if they should, and if they were told very aware maybe from professionals, or those who know more than I do in the fields about the importance of that how important they are to the health, I think they will be happy to jump on the bandwagon as I did. 06. CORK 3.2 KATE EWOMA Before now, I don't see any importance of it because you can't know the importance of what you don't know. So now I see the importance of it, how helpful it is to have. How to help you to monitor your health, health levels. Especially how to deal with cardiac health, like exercise helps in cardiac health. The awareness and understanding is better off now than before. Q1.1 What do you understand as the risk associated with lack of exercise or sedentary lifestyle, that is sitting in a place for a long time. You can narrate from here now. 23. DUBLIN 12.1 NAGOZY AMARA Sitting in a place for a long time or lack of exercise can cause one to be obese. It can also trigger some risk factors associated with maybe diabetes or high blood pressure and then so it is very, very you know, good for someone to actually put in at least 30 minutes a day, as part of exercise just to keep fit, even when you think you're very healthy, or you're healthy.	communication	communication about access to mHealth	Consumer access to mHealth was predicted by communication about mHealth			✓
	awareness	06. CORK 3.2 KATE EWOMA Before now, I don't see any importance of it because you can't know the importance of what you don't know. So now I see the importance of it, how helpful it is to have. How to help you to monitor your health, health levels. Especially how to deal with cardiac health, like exercise helps in cardiac health. The awareness and understanding is better off now than before. Q1.1 What do you understand as the risk associated with lack of exercise or sedentary lifestyle, that is sitting in a place for a long time. You can narrate from here now. 23. DUBLIN 12.1 NAGOZY AMARA Sitting in a place for a long time or lack of exercise can cause one to be obese. It can also trigger some risk factors associated with maybe diabetes or high blood pressure and then so it is very, very you know, good for someone to actually put in at least 30 minutes a day, as part of exercise just to keep fit, even when you think you're very healthy, or you're healthy.	awareness	awareness of mHealth	Consumer access to mHealth was predicted by awareness of mHealth			✓
	fitness awareness	Q1.1 What do you understand as the risk associated with lack of exercise or sedentary lifestyle, that is sitting in a place for a long time. You can narrate from here now. 23. DUBLIN 12.1 NAGOZY AMARA Sitting in a place for a long time or lack of exercise can cause one to be obese. It can also trigger some risk factors associated with maybe diabetes or high blood pressure and then so it is very, very you know, good for someone to actually put in at least 30 minutes a day, as part of exercise just to keep fit, even when you think you're very healthy, or you're healthy. 06.0 Considering what you know now, what do you perceive as the importance of the use of mobile health for you and for your family perhaps? 23. DUBLIN 12.1 NAGOZY AMARA And actually, almost everyone in my house need one. Because like I said, my husband, he has high blood pressure, high cholesterol level. So these we help track it down. Q1.2 Please can you narrate what do you perceive to be the risk of lack of exercise or sedentary lifestyle that is sitting in a place for a long time? 10 GALWAY 5.2 LANNA UGHO Lack of exercise is not good for the health. Well, inactivity generally obviously leads to obesity, health issues, muscle degradation, it's not good for human beings. Q4.0 Have you developed interest for health apps? Why, if you do, or why not, if you don't? 21 DUBLIN 11.1 OLUCHI CHRISTIE I am not too conversant with health apps out there. I know they exist. But this health coach, is actually the first trial ever for me. And somehow a kind of a, I have developed a lot of interest in this. I can't talk about any other one. 01. CORK 1.1 JOMBOS ERIC Well, I've developed interest on it, because it helped me now to know I'm healthy or not. Mostly watch when I drink a lot of water, it shows me green that I'm improving a lot and my weight, if I go on the scales in the morning.	fitness awareness	fitness awareness for mHealth	Consumer access to mHealth was predicted by fitness awareness			Consumer Access to mHealth
	user interest	23. DUBLIN 12.1 NAGOZY AMARA And actually, almost everyone in my house need one. Because like I said, my husband, he has high blood pressure, high cholesterol level. So these we help track it down. Q1.2 Please can you narrate what do you perceive to be the risk of lack of exercise or sedentary lifestyle that is sitting in a place for a long time? 10 GALWAY 5.2 LANNA UGHO Lack of exercise is not good for the health. Well, inactivity generally obviously leads to obesity, health issues, muscle degradation, it's not good for human beings. Q4.0 Have you developed interest for health apps? Why, if you do, or why not, if you don't? 21 DUBLIN 11.1 OLUCHI CHRISTIE I am not too conversant with health apps out there. I know they exist. But this health coach, is actually the first trial ever for me. And somehow a kind of a, I have developed a lot of interest in this. I can't talk about any other one. 01. CORK 1.1 JOMBOS ERIC Well, I've developed interest on it, because it helped me now to know I'm healthy or not. Mostly watch when I drink a lot of water, it shows me green that I'm improving a lot and my weight, if I go on the scales in the morning.	user interest	user interest for mHealth	Consumer access to mHealth was predicted by user interest for mHealth			✓
	fitness awareness	Q1.2 Please can you narrate what do you perceive to be the risk of lack of exercise or sedentary lifestyle that is sitting in a place for a long time? 10 GALWAY 5.2 LANNA UGHO Lack of exercise is not good for the health. Well, inactivity generally obviously leads to obesity, health issues, muscle degradation, it's not good for human beings. Q4.0 Have you developed interest for health apps? Why, if you do, or why not, if you don't? 21 DUBLIN 11.1 OLUCHI CHRISTIE I am not too conversant with health apps out there. I know they exist. But this health coach, is actually the first trial ever for me. And somehow a kind of a, I have developed a lot of interest in this. I can't talk about any other one. 01. CORK 1.1 JOMBOS ERIC Well, I've developed interest on it, because it helped me now to know I'm healthy or not. Mostly watch when I drink a lot of water, it shows me green that I'm improving a lot and my weight, if I go on the scales in the morning.	fitness awareness	fitness awareness for mHealth	Consumer access to mHealth was predicted by fitness awareness			✓
	user awareness	21 DUBLIN 11.1 OLUCHI CHRISTIE I am not too conversant with health apps out there. I know they exist. But this health coach, is actually the first trial ever for me. And somehow a kind of a, I have developed a lot of interest in this. I can't talk about any other one. 01. CORK 1.1 JOMBOS ERIC Well, I've developed interest on it, because it helped me now to know I'm healthy or not. Mostly watch when I drink a lot of water, it shows me green that I'm improving a lot and my weight, if I go on the scales in the morning.	user awareness	user awareness of mHealth	Consumer access to mHealth was predicted by user awareness of mHealth			✓
	user knowledge	01. CORK 1.1 JOMBOS ERIC Well, I've developed interest on it, because it helped me now to know I'm healthy or not. Mostly watch when I drink a lot of water, it shows me green that I'm improving a lot and my weight, if I go on the scales in the morning.	user knowledge	user knowledge of mHealth	Consumer access to mHealth was predicted by user knowledge of mHealth			✓

1.2	Suitability of mHealth	suitability of mHealth for physical exercise, body weight and personal health information was predicted by: 1.2.1 suitability of internet connection; 1.2.2 suitability of mHealth digital devices	Suitability of mHealth	MHealth SYSTEM INEQUALITY was predicted by Suitability of mHealth		
1.2.1	suitability of internet connection					
	Q7.0	What do you recall as key problems, challenges or concerns with the usage of the app or similar health innovation technologies?				
	broadband type of internet connection	08. CORK 4.2 AMAKA UCHENA So I think once you have [good] internet you're able to use it	broadband type of internet connection	suitable broadband internet connection	consumer access to mHealth was predicted by a suitable broadband internet connection	consumer Access to mHealth
1.2.2	suitability of mHealth digital devices					
	Q2.0	In what ways did you use this mobile health system, that is, the activity tracker on your hand, the weighing scale, and the health coach on your phone to monitor your daily exercise?				
	portability of the mHealth to carry	15 GALWAY 8.1 OKEY NICK So I've been monitoring for the weighing balance or the scale is for monitoring my weight and see if I've change the weight since I started. So I've improved in weight, I've lost some weight but is not em, is a few percent weight loss, which is not up to my target. But the wristband, the wristband app is very, very good because always on the wrist hand, and it's more is more portable. So I carry it everyone to go.	portability of the mHealth to carry	suitability of mHealth digital devices was predicted by the portability of the mHealth to carry	consumer access to mHealth was predicted by portability of the mHealth to carry	
	Q2.3	07. CORK 4.1 DAVE UCHENA What do you recall as key usefulness of the head coach, that is what things the app helps you to do, which you could not do without the app. App specifically. So in my sleep when I did use it, it showed me how well I slept that night, how long I slept at night. I was useful in monitoring like you are checking which times I should be sleeping shouldn't be sleeping, etc. So my weight, the information it expanded on the information I got from just stepping on the weighing scale, which you just saw me, my weight on the weighing scale and the app would break it down they would show me the fat percentage and muscle percentage BMI body mass index, water percentage etc. It broke down the information made it easier to digest. How easy was it to observe and understand the outcome of your physical exercises? Now that you have used the app, how easy was it to use, in comparison with the beginning and now?				
	usefulness of the mobile health devices	01. CORK 1.1 IOMBOS ERIC Okay, the beginning it was very hard for me to check, or go to the app and check which one is going into green, or which one is red. I was very difficult to me I have to keep trying to see how to check it. So as time goes, I get used, to it. So I can monitor all of them now when it's green now, or which one is improving and which one is not improving. So it's very easy for me to check now than before, when I don't have it, or when I started using it. So it's very easy for me now to check. 05. CORK 3.1 THEO EWOMA Actually, the first time was not too easy because of synchronizing it and the setup. So initially I was having a problem of setting it up and synchronizing it. 02. CORK 1.2 SHANNON ERIC The scale I think is really hard to use. Because if you're sharing with other people, then there's a lot of confusion at the state, unlike whose phone is getting the data from, but like I stopped using that I just use the step counter and sleep monitor and that's very easy to use. How seriously would you take this app if it was approved by the National Health Service Provider to serve as your health coach guiding you encouraging and supporting you?	usefulness of the mobile health devices	suitability of mHealth digital device was predicted by usefulness of the mobile health devices	consumer access to mHealth was predicted by usefulness of the mobile health devices	consumer Access to mHealth
	easy understanding of mHealth information	01. CORK 1.1 IOMBOS ERIC Okay, the beginning it was very hard for me to check, or go to the app and check which one is going into green, or which one is red. I was very difficult to me I have to keep trying to see how to check it. So as time goes, I get used, to it. So I can monitor all of them now when it's green now, or which one is improving and which one is not improving. So it's very easy for me to check now than before, when I don't have it, or when I started using it. So it's very easy for me now to check. 05. CORK 3.1 THEO EWOMA Actually, the first time was not too easy because of synchronizing it and the setup. So initially I was having a problem of setting it up and synchronizing it. 02. CORK 1.2 SHANNON ERIC The scale I think is really hard to use. Because if you're sharing with other people, then there's a lot of confusion at the state, unlike whose phone is getting the data from, but like I stopped using that I just use the step counter and sleep monitor and that's very easy to use. How seriously would you take this app if it was approved by the National Health Service Provider to serve as your health coach guiding you encouraging and supporting you?	easy understanding of mHealth information	suitability of mHealth digital device was predicted by easy understanding of mHealth information	User access to mHealth requires easy understanding of mHealth information	
	interoperability of digital devices	01. CORK 1.1 IOMBOS ERIC Okay, the beginning it was very hard for me to check, or go to the app and check which one is going into green, or which one is red. I was very difficult to me I have to keep trying to see how to check it. So as time goes, I get used, to it. So I can monitor all of them now when it's green now, or which one is improving and which one is not improving. So it's very easy for me to check now than before, when I don't have it, or when I started using it. So it's very easy for me now to check. 05. CORK 3.1 THEO EWOMA Actually, the first time was not too easy because of synchronizing it and the setup. So initially I was having a problem of setting it up and synchronizing it. 02. CORK 1.2 SHANNON ERIC The scale I think is really hard to use. Because if you're sharing with other people, then there's a lot of confusion at the state, unlike whose phone is getting the data from, but like I stopped using that I just use the step counter and sleep monitor and that's very easy to use. How seriously would you take this app if it was approved by the National Health Service Provider to serve as your health coach guiding you encouraging and supporting you?	interoperability of digital devices	suitability of mHealth digital devices was predicted by interoperability of digital devices	consumer access to mHealth was predicted by interoperability of digital devices	consumer Access to mHealth
	inferiority or superiority of mHealth devices	01. CORK 1.1 IOMBOS ERIC Okay, the beginning it was very hard for me to check, or go to the app and check which one is going into green, or which one is red. I was very difficult to me I have to keep trying to see how to check it. So as time goes, I get used, to it. So I can monitor all of them now when it's green now, or which one is improving and which one is not improving. So it's very easy for me to check now than before, when I don't have it, or when I started using it. So it's very easy for me now to check. 05. CORK 3.1 THEO EWOMA Actually, the first time was not too easy because of synchronizing it and the setup. So initially I was having a problem of setting it up and synchronizing it. 02. CORK 1.2 SHANNON ERIC The scale I think is really hard to use. Because if you're sharing with other people, then there's a lot of confusion at the state, unlike whose phone is getting the data from, but like I stopped using that I just use the step counter and sleep monitor and that's very easy to use. How seriously would you take this app if it was approved by the National Health Service Provider to serve as your health coach guiding you encouraging and supporting you?	inferiority or superiority of mHealth devices	suitability of mHealth digital devices was predicted by inferiority or superiority of mHealth devices	User access to mHealth requires superior mHealth devices	
1.2	Suitability of mHealth	Q6.1	How seriously would you take this app if it was approved by the National Health Service Provider to serve as your health coach guiding you encouraging and supporting you?			
1.2	Suitability of mHealth	Q6.1	How seriously would you take this app if it was approved by the National Health Service Provider to serve as your health coach guiding you encouraging and supporting you?			
	comparability of mHealth devices	18 DUBLIN 9.2 ETERNAL GODWIN Okay, okay, it's good, if they can recommended it. But I think it will be okay if it will be able to access all phones because some phones are not compatible. 18 DUBLIN 9.2 ETERNAL GODWIN There are some phones, some digital phones, like some phones that made from different companies that can't get in touch with the app properly, just like mine. And it can't function with everything in it. So I'll see they should make it available for all digital platforms.	comparability of mHealth devices	suitability of mHealth digital devices was predicted by comparability of mHealth devices	User access to mHealth requires comparability of mHealth devices	
1.2.3	Legacy mHealth devices (Smartphones)	18 DUBLIN 9.2 ETERNAL GODWIN There are some phones, some digital phones, like some phones that made from different companies that can't get in touch with the app properly, just like mine. And it can't function with everything in it. So I'll see they should make it compatible for all digital platforms.	comparability of mHealth devices	suitability of mHealth digital devices was predicted by comparability of mHealth devices	User access to mHealth requires comparability of mHealth devices	
	Q7.0	What do you recall as the key problems, challenges or concerns with the usage of the app, or any other app you have used for health?				
	compatibility of mHealth devices	17 DUBLIN 9.1 PROSPECT GOODWIN There are some say, for me, what I'll say is, there's some phones, some digital phones, like some phones that made from different companies that can't get in touch with the app properly, just like mine. And it can't function with everything in it. So I'll see they should make it compatible for all digital platforms.	comparability of mHealth devices			
	interoperability of digital devices	19 DUBLIN 10.1 CHI FOX The problem is I wasn't able to synchronize it to my phone. 02. CORK 1.2 SHANNON ERIC I think the being connected to many devices was kind of complicated. And the app was kind of struggling to understand who was doing what. And there's the band/sensor, it was sometimes it's easy to forget to have it because you're writing all the time. So I think it'd be better if it was like waterproof because you go in the shower, and you're like, Oh, I'm still wearing it, because you sleep with it, and you have it all day. So just small things like that. 07. CORK 4.1 DAVE UCHENA It's, I think I briefly touched on this point before with the Samsung adopters is it the user interface I don't know how exactly to call it. But if the amount of involvement of the user of the app like it, there are some apps that require more involvement and that can lead to some problems like but the watch in the required you to go to the sleep mode and then activate the sleep mode and then when you're done and you wake up the next morning, you have to turn it off exactly when you wake up which is a problem because people will be tired some nights when going to sleep they will please what other recommendations do you have for us to improve the use of mobile health for physical activities?	interoperability of digital devices	suitability of mHealth digital devices was predicted by interoperability of digital devices	User access to mHealth requires interoperability of digital devices	
1.2.4	water resistant digital devices	02. CORK 1.2 SHANNON ERIC I think the being connected to many devices was kind of complicated. And the app was kind of struggling to understand who was doing what. And there's the band/sensor, it was sometimes it's easy to forget to have it because you're writing all the time. So I think it'd be better if it was like waterproof because you go in the shower, and you're like, Oh, I'm still wearing it, because you sleep with it, and you have it all day. So just small things like that. 07. CORK 4.1 DAVE UCHENA It's, I think I briefly touched on this point before with the Samsung adopters is it the user interface I don't know how exactly to call it. But if the amount of involvement of the user of the app like it, there are some apps that require more involvement and that can lead to some problems like but the watch in the required you to go to the sleep mode and then activate the sleep mode and then when you're done and you wake up the next morning, you have to turn it off exactly when you wake up which is a problem because people will be tired some nights when going to sleep they will please what other recommendations do you have for us to improve the use of mobile health for physical activities?	water resistant digital devices	suitability of mHealth digital devices was predicted by water resistant digital devices	User access to mHealth requires water resistant digital devices	
	automated functions for mHealth devices	07. CORK 4.1 DAVE UCHENA It's, I think I briefly touched on this point before with the Samsung adopters is it the user interface I don't know how exactly to call it. But if the amount of involvement of the user of the app like it, there are some apps that require more involvement and that can lead to some problems like but the watch in the required you to go to the sleep mode and then activate the sleep mode and then when you're done and you wake up the next morning, you have to turn it off exactly when you wake up which is a problem because people will be tired some nights when going to sleep they will please what other recommendations do you have for us to improve the use of mobile health for physical activities?	automated functions for mHealth devices	suitability of mHealth digital devices was predicted by automated functions for mHealth devices	User access to mHealth was predicted by automated functions for mHealth devices	
	Q9.0	Please what other recommendations do you have for us to improve the use of mobile health for physical activities?				
	automation of mHealth devices	05. CORK 3.1 THEO EWOMA It's not something that will come up comes up automatic by itself. And you see like most of all things like people want to sleep, with the wristband, you know, you need to put it off and set it. So I don't know whether such provision will be made whether it is will be coming up automatic and tripping off when day is. You can see when most of this most people and houses when they set it or guess you know everything comes automatic. And even card and everything. So I think if this one will be coming automatic, I think that will be one of the good thing that will make the app more better, more suitable for people to use. 04. CORK 2.2 FAITH DURU So but if they can also put alarm, to wake you up, that you're sitting down so long stand up, stand up you know. You have to be busy don't just sit at a place I think that will also be nice.	automation of mHealth devices	suitability of mHealth digital devices was predicted by automation of mHealth devices	User access to mHealth requires automation of mHealth devices	
	functions such as reminders	03. CORK 2.1 CHUKY DURU It's to make it simple for people and modernize it in a way to be, it'll be easy for people to know. So as I say, to make the the health app waterproof. And, other things so that many people will like it and introduce it to people. 03. CORK 2.1 CHUKY DURU It's to make it simple for people and modernize it in a way to be, it'll be easy for people to know. So as I say, to make the the health app waterproof. And, other things so that many people will like it and introduce it to people.	functions such as reminders	functions such as reminders	functions such as reminders	
	mHealth usability	03. CORK 2.1 CHUKY DURU It's to make it simple for people and modernize it in a way to be, it'll be easy for people to know. So as I say, to make the the health app waterproof. And, other things so that many people will like it and introduce it to people. 03. CORK 2.1 CHUKY DURU It's to make it simple for people and modernize it in a way to be, it'll be easy for people to know. So as I say, to make the the health app waterproof. And, other things so that many people will like it and introduce it to people.	mHealth usability	mHealth usability	mHealth usability	
	water-resistant form factor	03. CORK 2.1 CHUKY DURU It's to make it simple for people and modernize it in a way to be, it'll be easy for people to know. So as I say, to make the the health app waterproof. And, other things so that many people will like it and introduce it to people. 03. CORK 2.1 CHUKY DURU It's to make it simple for people and modernize it in a way to be, it'll be easy for people to know. So as I say, to make the the health app waterproof. And, other things so that many people will like it and introduce it to people.	water-resistant form factor	water-resistant form factor	water-resistant form factor	
	Q8.1	In what ways did the app provide you quality coded information to understand your readings?				
	water-resistant and automated apps	07. CORK 4.1 DAVE UCHENA It gave it it displayed charts and a graph. And it's it was simple that was simple but effective and efficient is it had the different months, it was split into months, days, weeks, etc.	water-resistant and automated	water-resistant and automated	water-resistant and automated	
1.2	Suitability of mHealth	Q2.3	What do you recall as key usefulness of the head coach, that is what things the app helps you to do, which you could not do without the app.			
1.2.5	comprehension of mHealth information	07. CORK 4.1 DAVE UCHENA App specifically. So in my sleep when I did use it, it showed me how well I slept that night, how long I slept at night. I was useful in monitoring like you are checking which times I should be sleeping shouldn't be sleeping, etc. So my weight, the information it expanded on the information I got from just stepping on the weighing scale, which you just saw me my way to the weighing scale with the app would break it down they would show me the fat percentage and muscle percentage BMI body mass index, water percentage etc. It broke down the information made it easier to digest. How easy was it to observe and understand the outcome of your physical exercises? 05. CORK 3.1 THEO EWOMA Because of the line, because of the red line, the green line and the blue line, you know, it makes it easy to know, to read it to read in between the lines. So it just is quite simple because of the calibration. The calibration is simple, and it's easy to understand	comprehension of mHealth information	suitability of mHealth software apps was predicted by comprehension of mHealth information	User access to mHealth requires comprehension of mHealth information	Consumer Access to mHealth
	Q4.2	Yes, it was the it observe because every day you put in a number, and they make a graph for you and just statistics. And you can see one by will be height and other. And if you set your goal, there's like a line. And if it goes at the line or above the line, then it means you wish to go and you can see for like a week or a month, how many times you reached your goal or not right.	comprehension of mHealth information	suitability of mHealth software apps was predicted by comprehension of mHealth information	User access to mHealth requires comprehension of mHealth information	
	comprehension of mHealth information	05. CORK 3.1 THEO EWOMA Because of the line, because of the red line, the green line and the blue line, you know, it makes it easy to know, to read it to read in between the lines. So it just is quite simple because of the calibration. The calibration is simple, and it's easy to understand	comprehension of mHealth information	suitability of mHealth software apps was predicted by comprehension of mHealth information	User access to mHealth requires comprehension of mHealth information	
1.2.6	comparability of mHealth software	17 DUBLIN 9.1 PROSPECT GOODWIN There are some say, for me, what I'll say is, there's some phones, some digital phones, like some phones that made from different companies that can't get in touch with the app properly, just like mine. And it can't function with everything in it. So I'll see they should make it available for all digital platforms.	comparability of mHealth software	suitability of mHealth software apps was predicted by comparability of mHealth software	User access to mHealth requires comparability of mHealth software	

1.3 mHealth autonomy	was predicted by	autonomy of 1) digital devices(Smartphone , weighing scale, activity sensor); 2) system software and apps; and 3) internet connection	User control of mHealth	MHealth Use was predicted by user control of		
	Step 55	Whether mHealth experience is rewarding or stressful? <b>01. CORK 1.1 JOMBOS ERIC, INCIDENT REPORT</b> The participant noted that his experience with the mHealth was rewarding, and not stressful. The mHealth experience was also facilitated by the use of smartphone with unlimited mobile broadband internet connection.	the mobile internet broadband enabled a rewarding mHealth experience	User control of mHealth was predicted by mobile internet broadband connection	User autonomy of mHealth derives from type of internet connection	v
1.3.1	autonomy of internet connection	Whether mHealth experience is rewarding or stressful? <b>23. DUBLIN 12.1 NAGOZY AMARA, INCIDENT REPORT</b> The participant noted that the experience was rewarding and not stressful. The mHealth experience was made possible with the use of smartphone and with unlimited home and mobile broadband internet connection.	the Smartphone functionality enabled a rewarding mHealth experience	User control of mHealth was predicted by digital device functionality	User autonomy derive from digital device functionality	consumer Access to mHealth
	Step 55	Whether mHealth experience is rewarding or stressful? <b>12 GALWAY 6.2 GRACE ORAH</b> How seriously would you take this app if it was approved by the National Health Service Provider to serve as your health coach guiding you and encouraging and supporting you? I think I like that idea. But, the one I use, I like the idea but the one I use is manual. So I prefer something like digital and something that is like, you'll not be turning it up and down. So, I prefer automated.	manual or automated control	autonomy of mHealth was predicted by manual or automated digital device control	User autonomy derive from manual or automated digital device control	
1.3.2	autonomy of mHealth digital devices	In what ways did you use this mobile health system that is the activity tracker on your wrist, weighing scale and health coach app to monitor your daily exercise? <b>19 DUBLIN 10.1 CHI FOX</b> The one I used much is the activity tracker. Tracking my steps at work, going out. One I really used is the activity tracker because I'm always with it. And it works like that. But, the one I use, I like the idea but the one I use is manual. So I prefer something like digital and something that is like, you'll not be turning it up and down. So, I prefer automated.	mobility of mHealth devices	autonomy of mHealth was predicted by mobility of mHealth devices	User autonomy derive from mobility of mHealth devices	
	Q6.1	How seriously would you take this app if it was approved by the National Health Service Provider to serve as your health coach guiding you and encouraging and supporting you? <b>15 GALWAY 8.1 ONEY NICE</b> The wristband, the wristband app is very, very good because always on the wrist hand, and it's more is more portable. So I carry it everyone to go.	portable device			
	manual or automated control	What do you recall us key usefulness of the health coach that is what things the app helped you do, which you could not do without the app? <b>10 GALWAY 5.2 LANNA UGON</b> Generally it was very good. And again, the fact that I can just wear it on my wrist and it counts the steps and it showed the calories. <b>Q4.0</b> Please, have you developed interest for this health app; and why or why not? <b>06. CORK 3.2 KATE EWOMA</b> I have developed interest, because it's kind of handy. It's just something you take anywhere you want to go. <b>Step 60</b> <b>Q5.0</b> Please what other recommendations do you have for us to improve the use or mobile health for physical activities? <b>05. CORK 3.1 THEO EWOMA</b> So I think this one will be coming automatic, I think that will be one of the good thing that will make the app more better, more suitable for people	manual or automated control	autonomy of mHealth was predicted by manual or automated digital device control	User autonomy derive from manual or automated digital device control	
	Q2.0	In what ways did you use this mobile health system that is the activity tracker on your wrist, weighing scale and health coach app to monitor your daily exercise? <b>01. CORK 1.1 JOMBOS ERIC, INCIDENT REPORT</b> Whether you are on holiday, business trip or at the doctor's clinic, the application allows you to always view and track your values. Switch easily between weight, blood pressure, activity and sleep.	mobility of mHealth devices	autonomy of mHealth was predicted by mobility of mHealth devices	User autonomy derive from mobility of mHealth devices	
	portable device	Whether you are on holiday, business trip or at the doctor's clinic, the application allows you to always view and track your values. Switch easily between weight, blood pressure, activity and sleep.	portable device			
	Q2.3	Whether you are on holiday, business trip or at the doctor's clinic, the application allows you to always view and track your values. Switch easily between weight, blood pressure, activity and sleep.	mobility of mHealth devices			
	mobility of mHealth devices	Whether you are on holiday, business trip or at the doctor's clinic, the application allows you to always view and track your values. Switch easily between weight, blood pressure, activity and sleep.	mobility of mHealth devices			
	Q4.0	Whether you are on holiday, business trip or at the doctor's clinic, the application allows you to always view and track your values. Switch easily between weight, blood pressure, activity and sleep.				
	mobility of mHealth devices	Whether you are on holiday, business trip or at the doctor's clinic, the application allows you to always view and track your values. Switch easily between weight, blood pressure, activity and sleep.	mobility of mHealth devices			
	Step 60	Whether you are on holiday, business trip or at the doctor's clinic, the application allows you to always view and track your values. Switch easily between weight, blood pressure, activity and sleep.				
	Q5.0	Whether you are on holiday, business trip or at the doctor's clinic, the application allows you to always view and track your values. Switch easily between weight, blood pressure, activity and sleep.				
	automated mHealth control	Whether you are on holiday, business trip or at the doctor's clinic, the application allows you to always view and track your values. Switch easily between weight, blood pressure, activity and sleep.				
1.3.3	ubiquitous control access	Whether you are on holiday, business trip or at the doctor's clinic, the application allows you to always view and track your values. Switch easily between weight, blood pressure, activity and sleep.	ubiquitous control access	User control of mHealth was predicted by ubiquitous control access	autonomy of mHealth derive from ubiquitous control access	consumer Access to mHealth

2.0 M-HEALTH SERVICE UTILISATION INEQUALITY	a measure of differences or level of	Utilisation of mHealth for physical exercise, body weight and personal health information was predicted by	MHEALTH UTILISATION		
2.1 Demographic and Socioeconomic factors	associated with	Some common socio-economic themes include racial stereotyping, lack of contact and distrust of medical professionals, the lack of specialists from minority populations, language barriers and cost of items.	Demographic and Socioeconomic factors	MHEALTH UTILISATION was predicted by Demographic and Socioeconomic factors	
	Q2.0	What ways did you use the mobile health system that is the activity tracker, the weighing scale and the health coach app to monitor your daily			
	Age-contrasting adolescents, adults and older adults	<b>02. CORK 1.2 SHANNON ERIC</b> But I use the step counter a lot. Like when I was walking to school, I would already know how many I would get from that. And when I'm walking from class to class, and also when I come back from school and when I walk my dog, and I try usually to get around 10,000 steps per day, and if I don't, I don't like to walk out and have a bit more to get more steps because it's important for me to reach the goal.	contrasting age	contrasting ages of adolescents, adults and older adults	mHealth utilisation was predicted by age
	Gender- female versus male	Please can you tell us about your daily routines, especially, how busy you are and how much time you spend on physical activities daily? <b>14 GALWAY 7.2 EVELYN ALWELL</b> Before now was going to the gym every, let's say four times in a week for like, two hours. But at the moment of course I have an injury. I haven't been doing that.			
	the user's health status	What differences have you observed in your health reading on BMI, body fat, body water content, muscle percentage from when you started to the	contrasting health status	contrasting normal health status and injury	mHealth utilisation was predicted health status
	contrasting healthy individuals with individuals living with disability	<b>06. CORK 3.2 KATE EWOMA</b> My diet, like the food we eat as Africans has a lot of saturated fat in it and you need to do, you need to involve yourself in a rigorous exercise to get that fat out of your system when it's already in there.			
	Racial and ethnic factors such as cultural diets	How easy was it to observe the physical activity outcome, observation from your app <b>05. CORK 3.1 THEO EWOMA</b> Because of the line, because of the red line, the green line and the blue line, you know, it makes it easy to know, to read it to read in between the lines. So it just is quite simple because of the calibration. The calibration is simple, and it's easy to understand	contrasting cultural diets	contrasting African cultural diets and others	mHealth utilisation was predicted culture
	simplicity of communication language such as the use of colours for easy identification	What ways did you use the mobile health system that is the activity tracker, the weighing scale and the health coach app to monitor your daily	contrasting mode of communication	contrasting simple mode of communication with colours	mHealth utilisation was predicted language
	Education, literacy and skills	<b>02. CORK 1.2 SHANNON ERIC</b> But I use the step counter a lot. Like when I was walking to school, I would already know how many I would get from that. And when I'm walking from class to class, and also when I come back from school and when I walk my dog, and I try usually to get around 10,000 steps per day, and if I don't, I don't like to walk out and have a bit more to get more steps because it's important for me to reach the goal. <b>05. CORK 3.1 THEO EWOMA</b> Honestly, this is all about life, if everybody will have an access where they can be able to check their fitness and find out the state of their health, that'll be so perfect. But, because everybody wants life I know it's as a result of people's different categories of work or riches or assets to finance. Otherwise it is something that should be made to be common, especially to the poor. That means if the poor don't have an insurance, they will not live. So remember, we're talking about his life and living. <b>08. CORK 4.2 AMAKA UCHENA</b> I think Yeah, they agree that more health People who have more, I think, income, get more money have better health care than those who don't. So I do, I would just say yeah, in this society, it would be more beneficial to have free health to everyone. And I don't know, I think it comes with better circumstances and future if everyone is healthier.	contrasting skills	contrasting financial status of the poor and the rich	mHealth utilisation was predicted skills
	employment and income	What ways did you use the mobile health system that is the activity tracker, the weighing scale and the health coach app to monitor your daily	contrasting financial status	contrasting financial status of the poor and the rich	mHealth utilisation was predicted financial
	employment and income	What ways did you use the mobile health system that is the activity tracker, the weighing scale and the health coach app to monitor your daily	contrasting financial status	contrasting financial status of the poor and the rich	mHealth utilisation was predicted financial

2.2 consumer perceived benefits of mHealth in terms of		consumer perceived benefits of mHealth	mHealth utilisation was predicted by consumer perceived benefits in terms of	MHEALTH UTILISATION
2.3.1 opportunity to improve consumer PA and fitness performance				
Q3.1	Based on the health coach reading, what improvements have you observed on the color bars, and the graph of the BMI the body fat percentage, the body water contents and the muscle percentage.			
PAF tracker	02. CORK 1.2 SHANNON ERIC Content because when I drank my water, it showed how much more I drank. And it could help me find healthy amount to drink every day.	due to accuracy of PA and fitness information	consumer perceived benefits of mHealth in terms of accuracy of PA and fitness information	mHealth Service Utilisation was predicted by consumer perceived benefits of mHealth in terms of accuracy of PA and fitness information
PAF tracker	04. CORK 2.2 FAITH DURU When I started my BMI was almost a yellow yellowish. My body fat was red. My water was between yellow and red. Then my muscle was yellow and green and green. But now my muscle is green. My water level green, my body fats is yellow, strong green, nearly two gray. Then BMI is green. A very big massive improvement.	Perceived benefits of mHealth in terms of accuracy and easy to understand information details		
	07. CORK 4.1 DAVE UCHENA It was really good if you just want to quickly look at something and know whether it's increasing or decreasing self-checking numbers and crunching facts you just look at a chart and it shows a graph that says clearly increasing. That was that was really useful.	Ubiquitous access to personal physical activity and fitness information	immediate access to PA and fitness information	immediate access to PA and fitness information
Q3.3	What do you recall as key usefulness of the health coach app, that is what things the app helped you to do which you could not do without the app?			
continuous monitoring PA and fitness information	11 GALWAY 6.1 KEN ORAH Then with this health coach, I was able to, you know, monitor the water intake and that day and how many, you know, my body weight and the muscle and all those other things. And I kind of an eye opener because when I started I mean most of the things were on the other side of it, but when I know that there's a target that I was meant to be on the green side, I started walking towards that.	continuous monitoring PA and fitness information		
ubiquitous access to PA and fitness information	10 GALWAY 5.2 LANNA UGOH The app was good to see historical data. So I can always look back and see where I was and where I am now. And whether it was improvement or not.	ubiquitous access to PA and fitness information	ubiquitous access to PA and fitness information	ubiquitous access to PA and fitness information
Q3.0	From when you started using the mobile health, what improvement have you made on the time you spend on the daily exercise?			
motivation for ubiquitous PA and fitness participation	12 GALWAY 6.2 GRACE ORAH Maybe a lot of improvement. Because whenever I'm, I know that I'm working, and I'm going to be on the floor. I'm always happy, because I know I'll get my targets. I set up 10,000 targets. And whenever I like to make up the targets to 10,000, even if it's not to that bit. At least, almost 90%. And I'm happy about that.	motivation for ubiquitous PA and fitness participation	motivation for ubiquitous PA and fitness participation	motivation for ubiquitous PA and fitness participation
systematic planning of PA target	12 GALWAY 6.2 GRACE ORAH Because whenever I'm, I know that I'm working, and I'm going to be on the floor, I'm always happy, because I know I'll get my targets. I set up 10,000 targets. And whenever I like to make up the targets to 10,000, even if it's not to that bit. At least, almost 90%. And I'm happy about that.			
Q5.1	Question 5.1 Do these obstacles to mHealth still exist?			
opportunity for improved PA, consumer health education and promotion	01. CORK 1.1 JOMBOS ERIC No, it's better now I know about it. So it's very easy for me now than before. I can know why I, have to drink a lot of water. And I know how it's good for me to do exercise or go for a walk and get some exercise for myself; it makes me to improve my health. So it's really useful now that I know about it.	opportunity for improved PA, consumer health education and promotion	opportunity for improved PA, consumer health education and promotion	opportunity for improved PA, consumer health education and promotion
2.3.2 opportunity to improve consumer health and fitness outcomes				
Q1.1	What do you understand as the risk associated with lack of exercise or sedentary lifestyle, that is sitting in a place for a long time. You can narrate			
feedback information on fitness and dieting	23. DUBLIN 12.1 NAGOZY AMARA So with this health coach, it's motivated me I don't like drinking water. So but what I did this in this scenario was I had to put lemon, add lemon to my water just to bring up my water level in the body.	feedback information on fitness and dieting	feedback information on fitness and dieting	feedback information on fitness and dieting
Q6.1	How seriously would you take this app if it was approved by the National Health Service to serve as your health coach, guiding you encouraging and supporting you?			
mHealth evidence such as reduced number of GP visits	04. CORK 2.2 FAITH DURU Very, very, very, very helpful and very grateful and appreciate it. If they put it for everybody, it's good to use to monitor yourself. They say prevention is better than cure. If you can prevent it before going to a GP you know, you take care of yourself and know what to eat or know what to do. And if something is going wrong you know what to do earlier before going to GP. You know, like now we have fyu can see in Cork, how many people lying down in bed something beds hospital beds, so so many people. But fitness thing can be introduced in every house in every household.	mHealth evidence such as reduced number of GP visits	mHealth evidence such as reduced number of GP visits	mHealth evidence such as reduced number of GP visits
reduced number of emergencies and GP visits due to personal self-care for prevention	04. CORK 2.2 FAITH DURU They say prevention is better than cure. If you can prevent it before going to a GP you know, you take care of yourself and know what to eat or know what to do. And if something is going wrong you know what to do earlier before going to GP.	opportunity for reduced number of emergencies and GP visits due to personal self-care for	opportunity for reduced number of emergencies and GP visits due to personal self-care for prevention	opportunity for reduced number of emergencies and GP visits due to personal self-care for

2.3 consumer perceived constraints		consumer perceived constraint	mHealth utilisation was predicted by consumer perceived constraint such as	
QUESTION 2.0	In what ways did you use this mobile health system that is the activity tracker on your wrist, the weighing in scale and the health coach app on your phone to monitor your daily activities?			
Seeing their weight gives them bad feelings	20 DUBLIN 10.2 AMARA FOR when I weigh myself often it makes me to really have a bad day and I stopped. You know, because it doesn't really give me what I want. So I stopped			
Q7.0	What do you recall as key problems or challenges, with the usage of the app or similar health innovation technologies?			
has no time	04. CORK 2.2 FAITH DURU Also the time you know like what I said before I hardly do exercise because I was so busy. So these people are busy as well and they have no time to engage in any exercises. So that's the challenges.	has no time	availability of time	availability of time
busy with family	05. CORK 3.1 THEO EWOMA So by the time you take the children to school, some of the activities and house work and your own walk, you know, you find out that you have no time for the exercise and all those things. I think that's one of the major problem again, I see that is hampering the usage of this.	busy with family	being busy with family	being busy with family
Q7.1	Did the app interfere or disturb your routines, or usual way of doing things?			
has no time	01. CORK 1.1 JOMBOS ERIC Yeah, there was a lot of distraction from it, because I have to take some of my time to put it together to use it. Because of the busy, I'm a very busy person. So if I woke up I have to time myself, say 10 minutes I'm leaving the house now. So I don't have time to put that app on, or go to scale, or check my weight. So, I always abandon it most of the time because I have no time for it. And when I come back, I don't have time to check it again in			
Q9.0	What other recommendation do you have to improve the use of this mobile health, for yourself and for your family?			
busy watching TV	04. CORK 2.2 FAITH DURU Those of us sitting down in our living rooms, watching TV, watching sports, it's just for you to just to climb your staircase more than five times. It goes long way than sitting at a place doing nothing, we are lazy	sedentary life	involvement with sedentary life	involvement with sedentary life
Q1.0	Please, can you tell us a bit about your daily routines and mainly about how you balance work and fitness to maintain active lifestyle?			
busy with work and family	05. CORK 3.1 THEO EWOMA Actually I find it difficult to involve in some of this exercise because of my work schedules and family engagement. My kind of business is demands a lot of time and to find time to go into exercise is very difficult for me. Any little time I have I use it to sleep because that's one of the thing I need in my work. So all other little time then is to pick the children and you know assist in the family things. Because you know this part of the world, you			being busy with work and family
Q3.0	From when you started using the mobile health, what improvement have you made on the time you spend on the daily exercise?			
health status such as injury	14 GALWAY 7.2 EVELYN ALWELL As I said before, I haven't been I haven't gone back to the gym because of the injury I suffered. I suffered. So I haven't really engaged in more physical activities. But the only thing I know is that I do take a lot of work during my lunch. So let me say about 30 minutes a day.	health status such as injury	health status such as injury	health status such as injury
mHealth Knowledge and skills				
Internet skills				
Q3.1	From when you started, What improvement have you observed on the color bars of your health app for your BMI, for your body fat percentage, for			
skills with the App	04. CORK 2.2 FAITH DURU When I started my BMI was almost a yellow yellowish. My body fat was red. My water was between yellow and red. Then my muscle was yellow and green and green. But now my muscle is green. My water level green, my body fats. Yellow, strong green, nearly two gray. Then BMI is green. A	skills with the App	mHealth Knowledge and skills was predicted by interaction skills with the App	mHealth Service Utilisation requires interaction skills with the App
Q4.1	Now that you have used the app, how easy was it to use at the beginning and towards the end			
computer literacy	06. CORK 3.2 KATE EWOMA At the beginning of my usage of this app it was hard because I'm not computer, I'm not computer literate. But as time goes on, I start getting used to it. And towards this end, now, I think I can manoeuvre whatever that is in there, to suit my need.	computer literacy	computer literacy	mHealth Service Utilisation requires computer literacy
Q7.0	What do you recall as key problems or challenges, with the usage of the app or similar health innovation technologies?			
mHealth training	04. CORK 2.2 FAITH DURU The challenges it brings. People have to learn how to use it. And they should make it affordable to people. People should Yeah, they should train people to use it because like when I started, I don't know how to use it until I was trained how to use it. So people should be trained how to use it	mHealth training	mHealth Knowledge and skills was predicted by mHealth training	mHealth Service Utilisation requires mHealth training
Step 36-40	Activate your mobile phone Bluetooth; and Click on healthcoach			
mHealth usage experience	01. CORK 1.1 JOMBOS ERIC, INCIDENT REPORT This time, after the eight weeks mHealth usage period the participant was more familiar with the operation of the health app and all the devices. He showed great improvement in the demonstration of the mHealth use this time, blazing through all the IT tasks 37-40.	mHealth usage experience	mHealth Knowledge and skills was predicted by mHealth usage experience	mHealth Service Utilisation requires mHealth usage experience



3.2 Social Network: refers to the web of social relationships, integration and social ties that surround individuals	Integrate mHealth into social network		the web of social relationships, integration and social ties that surround individuals with	consumer mHealth utilisation was predicted by the web of social relationships, integration and social ties that surround individuals such as
family members	2.1	In what ways did this health coach app support your activities, especially with members of your family?		
family members	Q2	02. CORK 1.2 SHANNON ERIC When I was using the step counter, it would help me to track my fitness level and see if I was being active enough because if I'm sitting too much, that makes me not feel healthy. And so I can get proof of that from the watch. And also I compared it to my dad or sister, and then encouraged them to reach, and my daughter was also part of this program. Sometimes when she comes back, the first thing she asked is Mommy, did you reach your target? And sometimes, the too, she will not reach her target. So both of us and my son that was not even part of it, they got interested in it so we all	family members	relationship with family members
friends and peers	Q2.2	10 GALWAY 5.2 LANNNA UGHOH I would say that the health coach app support your exercise in relation with friends or community outside your family?	friends and peers	friends and peers
between parents and children	Q6.0	10 GALWAY 5.2 LANNNA UGHOH And I know that even our kids they're asking for the watch to wear and the scales to try and all wanted to know, what's their body mass what's their body muscle. So definitely would be nice for the whole family.	between parents and children	between parents and children
Friends and peers	Q9.0	23. DUBLIN 12.1 NAGOZY AMARA What other recommendations do you have to improve the use of mobile health for physical exercise especially for families like yours.		
	Q2.2	01. CORK 1.1 JOMBOS ERIC In what ways did this health coach app support your activities in relation with friends or community outside your family?	Friends and peers	Friends and peers
	Q5.0	10 GALWAY 5.2 LANNNA UGHOH Despite the popularity of mobile devices, it is surprising that you did not use them for the benefit of your health and wellbeing. Before the introduction of this app to you, what was your reasons for not using any mobile health?		
group of students	Q2.2	10 GALWAY 5.2 LANNNA UGHOH I've have more than one or two people, it creates a little bit of competition encouragement, and I would encourage things like this to be more on a bigger scale, I guess not just within the family. Include your friends, your co-workers, if the workplaces can introduce some kind of app that everybody measures and can I check the all that he said. some kind of targets that they can achieve. to encourage them a little bit more.	group of students	group of students
Health care professionals	Q6.1	01. CORK 1.1 JOMBOS ERIC How seriously would you take this app if it was approved by the National Health Service Provider to serve as your health coach, guiding you encouraging and supporting you?		
	9.1	01. CORK 1.1 JOMBOS ERIC Do you have any other information to share in this interview?	with Health care professionals	with Health care professionals
mHealth professionals	Q4.1	15 GALWAY 6.1 KATE EWOMA Now that you have used the app, how easy was it to use at the beginning and at the end?	mHealth professionals	mHealth professionals
	Q4.2	06. CORK 3.2 KATE EWOMA I needed someone to explain to me very well about it, but I call the, the, how would I say it. I called on the person that introduced it to me, to explain the devices, display on screens. Select the weighing scale SB70, (Healthcoach will search for the weighing scale)		
staff members at work place	Q2.2	23. DUBLIN 12.1 NAGOZY AMARA, INCIDENT REPORT The participant received technical assistance from the researcher to complete task steps 16. "From all the devices displayed on screen. Select the weighing scale SB70, (Healthcoach will search for the weighing scale)". The researcher involvement was needed at this stage to select and		
	Q5.0	10 GALWAY 5.2 LANNNA UGHOH I've have more than one or two people, it creates a little bit of competition encouragement, and I would encourage things like this to be more on a bigger scale, I guess not just within the family. Include your friends, your co-workers, if the workplaces can introduce some kind of app that everybody measures and can I check the all that he said. some kind of targets that they can achieve. to encourage them a little bit more.	staff members at work place	staff members at work place

3.3 Social Support as a support from			Social Support	
3.3.1	family interaction			
	Q2.1	In what ways did this health coach app system support your activities, especially with members of your family?		
	Q4	04. CORK 2.2 FAITH DURU Yeah, like myself and my husband, we used it. We always compare how many steps I do today. So if he's not taking enough step, I said, Man, you have to start walking, even if it's just your house. Yeah, just involve yourself going around. Just to make to just be you have to be busy doing something not sitting down. So we always discuss about how many steps we have, and we discuss about our water level and you know, everything about the app. So we need to push ourselves. And we have to try and get to so so steps, or so so thing for your way, you know. We always look at our weight. So it has helped us both. My kids also they always ask hi, mommy how're getting on with it. How're you getting on with it. Yeah, I'm getting the so can we see. Can we see? So they also get involved just to know how I've have improved or not. So do they will say yesterday you improved, we want you to get more in order to reduce. We want you to do this, or do this. So we just discussed about this as a family.	support families in mHealth PA communication	support families in mHealth PA communication
	Q5	05. CORK 3.1 THEO EWOMA I think with the app now, it makes me to be conscious of it you know. Before, before, like I said, that I barely do any exercise. But when I remember it now knowing what I have, and the scale is a kind of a place. That's, that's one of the things I remember, and use, that motivates me to do something. Actually before I do nothing, but now I think I take a little exercise, like running my steps up and down you know. From above my step up and down. And again, doing some press up you know. This things I don't even do it before, but because of this app I think it makes me to remember. Even though not as often as I can as I supposed to use them. And this step, I think it's helping me. I think it's a little bit good for me. Then with the member of my family, I think that is, I introduced it to my wife. And my wife now, I incorporated her into it. Although my children, the only thing is that I didn't set them up in the system. But especially my little daughter, in fact, whenever I'm doing it she, she she's, she's like my coach. You know, she's coaching me she's doing, but I didn't incorporate her into the app system. So but my wife has she's doing a little bit exercise as		
	Q10	10 GALWAY 5.2 LANNNA UGHOH It was good, with my husband, sometimes we will discuss who did what and how many steps you've done. I guess the more family members are involved, the better. We can then all kind of compete with each other and see who's done more. We use something similar in Boston Scientific at work and it's very encouraging. And translating it into competition encourages people to do better and to do more.		
	Q11	11 GALWAY 6.1 KEN ORAH Well, it's helped, I would say it helped much because, like I know even myself and my wife, you know, we don't talk much about exercise. But because we have this so we always kind of monitor each other and sometimes we want to discuss about how many steps she covered in a day, and		
	Q20	20 DUBLIN 10.2 AMARA FOX I did with this health coach I was doing it with my daughter, so we track ourselves. At the end of the day we check how many steps we have gone and how many calories we burn.		
	Q21	21 DUBLIN 11.1 OLUCHI CHRISTIS But one of my daughters to be frank actually said Mom, you must buy one for me, because I'm actually interested in that.		
	Q6.0	02. CORK 1.2 SHANNON ERIC Considering what you know now, what do you perceive as the importance of the use of em health for you and for your family?		
	Q2	02. CORK 1.2 SHANNON ERIC I think it's important because you can track your health easily, especially if you having problems with it or difficulties. Keeping track of your progress, if you're struggling with sleep, or exercise, so you can check up on your family and encourage them to improve themselves.		
3.3.2	interactive support with friends and peers			
	Q2.2	In what ways did the health coach app support your activities in relation with friends or community outside your family?		
	Q4	04. CORK 2.2 FAITH DURU Yeah, people do ask me. What was this about? So I'll always tell them. And I will just show them the information that transferred from the app to my phone. They will like, oh, they like it. And it's very nice. I just showed them everything. So they're happy, they want to start using it. They think that it's just at a glance you know about your health. Now but everything about yourself at a glance without somebody telling you because the app is transferred to your phone and then you everything will just show you. Yes you're improving, or you're not improving or anything about your	interactive support with friends and peers	interactive support with friends and peers
	Q9	9 GALWAY 5.1 JEFF UGHOH In that regards, I could say that, it kind of generated interest amongst my friends and they wanted to be part of the program. And sincerely speaking it actually motivated a few of my friends to start getting more active and change certain things in their lifestyle.		
	Q17	17 DUBLIN 9.1 PROSPECT GODWIN It actually catches my friends mostly they ask questions of what I'm doing. And they see what I'm wearing in my wrist. So they all want to have a clue and know about what I'm doing.		
	Q2.1	In what ways did the health coach app system support your physical exercise, especially with members of your family, even in a discussion?		